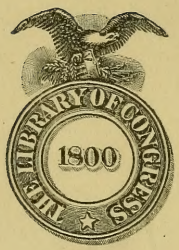
LESSONS IN

FRUIT GROWING

GOFF



LESSONS

IN

COMMERCIAL FRUIT GROWING

A TEXT-BOOK FOR BEGINNERS

BY

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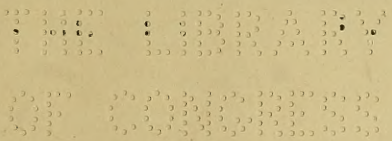

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PREFACE

This book, like its predecessor, "Principles of Plant Culture," has grown up in the class room. As in that work, the text is briefly stated, with the expectation that the instructor will amplify it by questions and by additional facts from his experience, observation or reading. This book is intended as a supplement to "Principles of Plant Culture," hence information given in that book is not repeated here, as a rule.

While good horticultural books are much more numerous than they were a quarter of a century ago, the author has been able to find no single book that presents concisely the information he desires to give his students in fruit growing. This is his apology for offering another book. It is hoped that the topical arrangement of the subject matter, the cross-references, the summaries following the chapters or sections, and the suggestions for laboratory work will commend this book to other instructors.

A list of books is appended at the end (page 212), for the benefit of those who desire to pursue the subjects further.

Madison, Wis., Feb. 1, 1902. E. S. GOFF.

ACKNOWLEDGMENTS

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The books mentioned on page 212, and a few others, have been freely consulted in the preparation of this work, and the assistance thus gained is gratefully acknowledged.

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LESSONS IN COMMERCIAL FRUIT GROWING

CHAPTER I

GENERAL CONSIDERATIONS

1. Definitions. The word *fruit*, as used in American horticulture, may be defined as the edible part of a perennial plant that is closely connected in its development with the flower. This definition includes the nuts, which for convenience, are now classed with fruits in matters relating to culture. *Pomology* or *fruit growing* is the art or science of raising fruit. *Commercial fruit growing* is the raising of fruit primarily as a means of earning a livelihood. It includes the raising, the handling and the marketing of fruits, especially in large quantities.

2. Present condition of fruit growing. Fruit growing in the United States and Canada is now passing through a transition period, especially as regards the tree fruits. The old-time farm orchard is slowly disappearing. The production of fruit, however, is rapidly increasing, but the increase is due mainly to the establishment of large commercial orchards. Fruit growing, in other words, is following in the line of other industries and is being more and more conducted on a large scale, and often with combined capital and according to strict business methods. As the result, fruit is being produced more cheaply, and of better quality than formerly.

3. The education required. Commercial fruit growing requires education along two distinct lines. 1st. The

person who grows the fruit needs a knowledge of plant life and plant development, especially in relation to the particular plants he desires to grow; and 2d, the person who attends to the business matters connected with the growing and disposition of the fruit needs a knowledge of business methods in general, and especially as related to the handling and marketing of fruit. A knowledge of vegetable physiology, of chemistry and physics as applied to agriculture, and of controlling the parasitic enemies of fruit plants forms the basis for the first kind of education; a knowledge of commercial methods, including bookkeeping, and of packing and shipping fruit forms the basis for the second.

Some knowledge of the manufacture of fruits into secondary products is also important.

Success in commercial fruit growing will depend much upon the extent to which these two kinds of education are combined. The same individual need not possess education in both lines; indeed both are often in demand at the same time and in different places. If an extensive fruit business is undertaken, it will be better to have one person make a specialty of each of these departments.

The foundation for the first kind of knowledge is best attained in an agricultural college; that for the second in a business college. Both should be supplemented by practical work for a time in a successful commercial fruit business.

4. The outlook for commercial fruit growing. Both the production and the consumption of fruit are increasing in most civilized countries. The methods of production, storage, distribution, manufacture and preserving of fruits tend to improve and to become cheaper. The number of persons

who are able to appreciate and to pay for strictly choice fruit is increasing. The opportunities for business success in fruit growing are perhaps as numerous and as favorable as in any other productive industry. There is plenty of "room at the top." It is doubtful, however, if one branch of productive industry will prove permanently more remunerative than another. Aside from personal aptitudes and tastes, which should never be ignored, an occupation is desirable in proportion as it promotes the broadest development of those who follow it. Viewed from this standpoint, few occupations are more desirable than commercial fruit growing.

5. The kinds of fruit grown will depend somewhat upon whether a location is to be selected, or ground already owned is to be used. In the first case the market and the personal tastes of the grower should be considered, and the location selected that is best adapted to the chosen fruit or fruits. In the second case the adaptability of the different fruits to the soil and climate of the tract to be used, should first be considered. As a rule the fruit will pay best that is best adapted to the soil and climate. It is generally wiser to grow two or more fruits than to depend upon one, as the chances of crop failure are thereby reduced.

6. The choice of a location. This will necessarily depend much upon the particular fruit or fruits it is desired to produce. The location chosen, however, should be governed by two principal considerations, viz.: 1st, the favorableness of the soil and climate to the production of the fruit or fruits it is desired to produce, and 2d, the opportunities for marketing the fruits.

1st. *The conditions of soil and climate* required differ greatly with different fruits, and will be treated specifically

in the proper places, but certain general requirements may be mentioned here.

a. *Length of season.* The warm season should be sufficiently long to properly mature the fruit or fruits it is desired to grow. The quality of fruits depends more or less upon their receiving a given amount of solar heat during the growth period. Thus the grape only attains its highest quality when grown in a warm climate. Conversely, the season may be too long and warm for the highest quality and best keeping of a given fruit, as is true of the apple in southern United States.

b. *Freedom from damaging frosts.* This depends more upon local environment than upon latitude. Altitude, aspect and proximity to bodies of water should receive the most careful attention in locating the fruit plantation.*

c. *Shelter from prevailing winds.* A location that is sheltered from the prevailing winds by natural barriers, as elevations of ground or forests, is preferable to one not thus sheltered, especially for the tree fruits. In otherwise favorable locations, damage from winds may be in part averted by growing a *wind-break* on the side of the plantation toward the prevailing winds. (10.)†

2d. *The market conditions.* The market, to the commercial fruit grower, means the party or parties that buy the fruits, and has no necessary relation to the place where the fruits are consumed. Sometimes the buyer goes to the farm and buys the fruit, even before it is mature; at other times the fruit is shipped a long distance — perhaps across the ocean — before it finds a buyer. The transaction may

* The relation of these conditions to damaging frosts is considered in detail in "Principles of Plant Culture."

† A number in parenthesis in the text refers to another paragraph that gives further information on the same subject.

be equally profitable in both cases. The market is a less definite and a less stable factor than the conditions of soil and climate. A few principles, however, can be laid down.

a. *Transportation facilities.* To avoid carriage by wagon and transfer after shipment, fruits for the commercial business are preferably grown near some through line of transportation. Two such lines are preferable to one, as competition will thus tend to lower shipping rates, and there will then be greater security in case of strikes or other temporary obstructions to commerce. As a rule, the larger the number of transportation companies within reach of the fruit plantation, the better.

b. *Shipping quality.* The more delicate and perishable the fruit produced, the more important is it that it should be grown near a large center of population. The strawberry cannot be shipped long distances and be delivered to the consumer at its highest quality, though winter apples may be shipped across the ocean without deterioration.

Locations may sometimes be found where special fruits may be grown outside of their normal climatic belt. Thus peaches are produced considerably farther north on the east side of Lake Michigan than is possible in the Eastern States, and oranges may be grown in the thermal belts of the Sierra Nevada mountains as far north as Philadelphia. Fruits that can be well grown outside of their normal belt are usually more profitable than those grown in it, because local competition is thus restricted.

A market may sometimes be developed where it does not already exist. Since fruits do not usually rank among the necessaries of life, their consumption depends largely upon their cheapness and quality. In order to develop a market for fruit we must supply the products of fine quality and in

an attractive form. As their value becomes known, the demand for them will increase.

The most profitable markets for fruits are not always the largest towns and cities, since these, drawing their supply from extensive areas, are generally better stocked than smaller communities.

3d. *Other conditions.* Aside from soil, climate and market, other conditions should be considered in locating the fruit plantation:

a. *The ability to procure the desired manual labor* at a reasonable cost. This need not necessarily be skilled labor, as few of the operations of fruit culture are difficult to learn. More or less of transient labor will be needed, much of which may in some cases be performed by women and children. A location near a thickly-settled community is almost a necessity for small-fruit growing, in which much extra labor is needed during the harvest season.

b. *An available supply of manure* or fertilizers at prices that the market value of the crops will warrant. Home-made manure is cheapest, but cannot often be provided in sufficient quantity. Manure can usually be most cheaply purchased in the neighborhood of a town or city, but is sometimes available elsewhere, as from railways, slaughter-houses, glue factories, etc. Commercial fertilizers may be ordered directly, or through agents, to be delivered at the nearest freight depot.

c. *Proximity to fruit establishments.* A location near a canning factory, fruit evaporator, or a jelly, jam, cider or vinegar factory is desirable as offering a means for disposing of the lower grades of fruit.

d. *Proximity to package manufactories.* A location near a factory that turns out the kinds of packages most used on the fruit plantation, is an incidental advantage.

7. The selection of varieties. Success in commercial fruit growing depends much upon the selection of the proper varieties for growing. These must be so well adapted to their environment that they will be regularly productive, and their fruit must be of a character that commands a good price. Most varieties can be grown to perfection only in certain districts, and it is usually difficult to ascertain what varieties will do best in a given locality. Much may be learned from reading, from observation and from the experience of fruit growers and fruit dealers, but the grower will still find it necessary to experiment largely for himself. A "trial ground" is an essential part of the commercial fruit plantation.

The successful market varieties of the different fruits vary in different localities and at different periods. It is, therefore, impracticable to recommend a list of varieties in a work of this kind.

8. Commercial and domestic varieties. Varieties may be divided into two classes with reference to the trade for which they are grown. Those intended for sale in the open market, especially if they must be shipped, require different properties from those intended for delivery direct to the consumer. The former may be called *commercial varieties*, the latter *domestic varieties.*

Commercial varieties demand attractive appearance, large size and good carriage and keeping qualities. High edible quality is generally considered of secondary importance. It should be remembered, however, that fruit is purchased by the consumer primarily for its pleasing and refreshing edible qualities, and that the more pleasing and refreshing a given sample is found to be, the more of it will be purchased as a rule. High edible quality should be regarded as one of the essentials of a market variety.

Domestic varieties demand special adaptation to some particular purpose, as for dessert, for canning, for jam or for jelly, rather than attractiveness or keeping quality. Domestic varieties require the higher skill in their production and marketing, and they often yield the larger and surer profits. They cannot, however, always be sold in as large quantities as commercial varieties.

9. Procuring stock for planting. Some pomologists are of the opinion that the selection of cions and buds for propagation from productive individual plants is essential to the best success in fruit culture. While this proposition may not have been demonstrated, it is probably true and prudence would dictate its careful observance. This, however, will necessitate that the fruit grower become a nurseryman. At any rate the stock needed for the fruit plantation can generally be purchased cheaper and much quicker from a professional nurseryman, than it can be grown in the quantities commonly needed for planting. In buying stock, the locality, the seller and the time of year are points to be considered.

The locality where stock should be purchased. The nearer by the stock can be found, the more cheaply can it be delivered, and the shorter is the time needed for transportation. Stock grown under conditions most similar to those under which it is to be planted is generally preferable, but probably more depends upon the condition of the stock when planted than upon its nativity. The best way is for the purchaser to go to the nursery, select and dig the stock, and have it delivered at his grounds without boxing or baling.

The parties from whom stock should be purchased. Stock must generally be purchased from one or more nurserymen

or nursery middlemen. Since it is often impossible to distinguish varieties of young stock with certainty, the purchaser must depend much on the integrity and care of the seller. As nurserymen are commonly more thoroughly established, and have more capital invested than middlemen, they are generally more anxious to maintain a good business reputation. The more times the stock changes hands the greater is the liability to mistakes. For these reasons it is usually safer to deal directly with the growers of the stock, and when considerable quantities of stock are to be purchased, the middleman's commission can often be saved by so doing. Traveling nursery agents are usually least reliable of those who handle nursery stock, and their prices are apt to be highest.

The time to purchase stock will depend upon the time the planting is contemplated, and this will naturally vary with the kind of fruit and the climate. It is generally best, however, to order early, while the nurseryman's assortment is complete, and before his hurrying season arrives. Specific orders should be given as to the time the stock is desired for planting in order that the nurseryman may know when to ship it. In climates of severe winters it is often wise to have trees delivered in autumn for spring planting, and to bury them in a well drained place until spring.

10. Wind-breaks. A wind-break is a planting, usually of trees or tall shrubs, intended to break the force of winds. It generally consists of one or more rows of rather closely-planted trees, and is usually located to serve as a shelter from the prevailing winds only. Wind-breaks are helpful to the fruit plantation, as a rule, unless it is already protected from severe winds by natural barriers. They tend

to reduce evaporation, to retain snow and leaves on the ground in winter, and they facilitate work in the plantation in windy weather. In orchards they lessen wind-falls, the breaking and bending of trees and damage to blossoms.

A wind-break may prove injurious by intercepting winds that are tempered by a near body of water, thus increasing the cold, and sometimes by promoting frost to the leeward by obstructing air currents. These effects may be largely avoided by planting the wind-break thinly for such exposures, thus permitting some movement of the air between the trees. A wind-break may sometimes favor injurious insects and fungi, and may cause a dearth of soil water in the near vicinity, but these effects may be largely obviated by the use of parasite preventives, as spraying, by good cultivation, and in the case of orchards, by planting the wind-break at the same time as the trees, and at a liberal distance from them.

As a rule, a closely planted wind-break, as of the denser evergreens, is preferable for plantations not perceptibly influenced by a body of water, and with good cold-air drainage. Deciduous trees or thinly-planted evergreens are often preferable near a body of water or where the cold-air drainage is interrupted.

The Norway spruce is most extensively planted as a wind-break in northern United States. Nut trees have been suggested as a wind-break for fruit plantations, but they would generally grow too slowly and too open at the bottom, while the close planting necessary for the purposes of a wind-break would be unfavorable to the production of nuts.

11. Designation of varieties. The names of varieties planted for fruiting should be preserved. The varieties

should be designated in the field by appropriate stakes or labels, but as these are subject to many accidents and are rarely durable, an additional record should be kept. A map of the plantation, on which every variety is located and named, is very convenient for reference, but where it is desired to preserve notes of the different varieties, a book or card catalogue is also desirable. If a book is used, a page may be devoted to each variety, or to each individual tree or plant if desired, and the names of the varieties may be indexed for reference. The card catalogue is perhaps best, especially for large plantations. In this method, the name or number of each variety, tree or plant of which it is desired to preserve notes, is written near the top of a card, and the cards are arranged in a box or drawer in the same order in which the names occur in the plantation. The cards indicating the varieties in one row may be inclosed in a rubber band. The different fruits may be separated by wider cards or by pieces of thin board. The cards should be large enough for recording all needed data. If a tree or a variety is removed from the plantation, the card corresponding to it is taken out of the box; or if one is transplanted, its card is removed in like manner. Thus the list is not cumbered with varieties no longer grown, and shows every variety in the plantation in its proper place. Where many varieties are grown a supplementary card catalogue, in which each card contains the name of one variety and designates its location, and in which the names are arranged in strict alphabetical order, is also needed for locating varieties of which the place has been forgotten.

12. Harmful parasites and diseases. The fruit grower must be watchful for these during the growing season, or much harm may result before the cause is discovered. The

insects and diseases that affect the different fruit plants will be treated separately for each class, but largely the same apparatus and materials will be needed for all. A good spraying pump with an attachment that secures a uniform mixture of the materials, and that is capable of spraying kerosene and water together, with a nozzle that gives an adjustable spray, with ready unclogging facilities, will be almost indispensable, as will conveniences for preparing the Bordeaux mixture.* The capacity of the spraying apparatus needed will depend much upon the size of the plantation. For large plantations, a pump operated by horse power will be very useful, while one operated by steam may be needed for those of the largest size.

13. The conditions affecting fruitfulness are but partially understood. In a climate favorable to a given fruit, fruitfulness probably depends more upon variety than upon outside conditions. Of the latter, those that promote a healthful condition of the plant and moderate growth doubtless tend to normal fruitfulness. Vigorous growth is generally opposed to fruitfulness, and so are severe drought and insufficient potash and phosphoric acid in the soil. An excessive crop of fruit is apt to be followed by a partial or complete failure of crop. The flower buds of our fruit plants are formed the season previous to their expansion, and the weather during or just preceding the flower-forming period most likely exerts a potent influence upon the number of flowers formed. The weather during the expansion of the flowers and the setting of the fruit is probably also potent. But excepting the effects of frost at blooming time, these influences are, as yet, little under-

*For a discussion of various insecticides and fungicides, and directions for preparing the Bordeaux mixture, see "Principles of Plant Culture."

stood. In fruits of which the flower buds are more subject to harm from cold than the leaf buds, as in the stone fruits, the flower buds are often destroyed in winter.

14. The self-sterility of varieties. Recent investigations have shown that many, perhaps most, varieties of fruit are infertile to their own pollen: *i. e.*, their flowers will not set fruit unless their stigmas receive pollen from some other variety. For example, the Bartlett pear fruits well only when its stigmas receive pollen from some other kind of pear than Bartlett. The limits of self-sterility have not been determined, but until they are determined it is wise to mingle varieties freely in the fruit plantation, rather than to plant large blocks of a single variety. As a rule, more than two rows of a given variety should not be planted together. Care should also be taken to plant varieties together, so far as practicable, that bloom at the same time.

15. Fruit packages should be provided early to avoid delays in harvesting. They may often be advantageously secured during the winter, so that they can be nailed up and branded when time is less valuable than during the growing season. They should be stored in a dry place where the sun cannot shine upon them, and away from rats and mice. Damp package-material to be kept some time before putting in shape should be piled loosely to prevent mildew. As the package is influential in selling the fruit, neatness in its appearance is important. Second-hand packages should only be used for inferior fruit. The different kinds of packages are considered in connection with the fruits for which they are used.

The requisites to a good package are (a) sufficient strength, (b) neatness, (c) cheapness and (d) lightness. "Gift" packages, *i. e.*, those that are furnished free with

the fruit are usually most satisfactory. A returnable package must be made comparatively heavy and costly to provide sufficient strength; it soon becomes soiled from use, and often causes trouble by not being promptly returned.

The grower's name and address should be put upon every package of good fruit, and an attractive trade-mark will aid in securing a reputation.

16. When and how should fruit be picked? With a few exceptions, of which the pear is one (77), fruit reaches its highest edible quality when left attached to the plant until fully ripe. The stage of ripeness at which it should be picked, however, depends upon the market. Fruit supplied direct to the consumer should be picked and delivered when in best condition for the use intended. If for dessert, it should be picked fully ripe; if for canning it may need to be picked a little hard. The purchaser should generally be consulted on these points.

Fruit that must be shipped to market should be picked sufficiently hard, and be so packed as to endure the journey without damage from bruising. Allowance should be made for the time required in, and the manner of transit, for the season, the weather and the variety. Fruit that is to be but one hour in transit may be picked riper than that which will be five to ten hours on the journey; that which is to be carried by water may usually be picked somewhat riper than that which is to go by rail for a similar time. Tender-fleshed varieties should be picked less mature than firm-fleshed ones.

Abrasions of the skin and bruises, however small, detract from the market value and keeping quality of fruits, and hence should be carefully avoided. The bloom of fruits possessing bloom should be preserved intact. Fruit should

only be picked while the skin is dry, as a rule, and should never be permitted to become wet after picking, for moisture on the skin promotes decay. Nor should picked fruit be exposed to the sun's rays in warm weather. The more tender the fruit, the more important is it to observe these precautions. As a rule, the sooner fruit can be removed to the packing or storing house after picking, the better.

17. Grading and packing. First impressions are potent in forming judgment, hence fruit exposed for sale should be put up to present the finest appearance consistent with honest packing. Uniformity of size and quality in the package promotes a favorable impression, hence fruits should be graded, so far as practicable, and different grades should be separately packed. An intelligent buyer seldom offers much more for an ungraded package of fruit than he regards the poorer samples worth, hence the better specimens sell for less than their value. If the quality is uniform throughout the package, an artistic arrangement of the specimens on the exposed part is legitimate and commendable.

18. Packing houses. Where large quantities of fruits are grown, a building will be needed for packing and temporary storage. The character of this building will depend somewhat upon the time the fruit is expected to remain in it. If the building is to serve the purpose of a winter storehouse for long-keeping fruits, it should be provided with a cellar that can be kept from freezing in severe weather. It is also desirable to have a compartment connected with the packing house for the storage of package material, but this is generally a second-story room. The size of the building will of course depend much upon the amount of fruit produced. It should be arranged with reference to conven-

ience in loading and unloading fruit from a wagon, and if intended for the tree fruits, it should have well-lighted assorting tables at convenient points.

As it is important that the temperature of the packing house be kept cool as possible, a location that is shaded by trees is preferable, and the house should generally be ceiled, plastered or papered inside, in such manner as to provide an air space in the wall. Care should also be taken to keep the building free from rats and mice.

If the house is built in a depression where cool air settles at night, it may be kept considerably cooler than if located on higher ground, but it should be remembered that the location that is coolest in summer will also be coldest in winter.

19. Storage of fruit. Cold-storage houses are so costly that only extensive fruit growers can afford to provide them. If the grower desires to keep his produce much beyond its normal ripening period, he will generally do better to place it in a commercial cold-storage house, paying the required rate for the privilege.

The storage house is most economically kept from freezing in severe winter weather by sinking the floor more or less below the surface of the ground. It is generally preferable to do this even in climates of mild winters, because this aids in keeping the storage room cool. The depth to which the floor is sunk below the surface should depend upon the severity of the winter climate. It is neither desirable nor economical to depend on artificial heat to keep out frost. The portion of the wall built above ground, whether of wood or other material, should be provided with at least one dead-air space, and if wood is used, a layer of building paper outside and inside of the wall will

tend to keep out heat and cold. The roof of the storage room should also have at least one dead-air space. If the storage room is placed beneath the packing room, this is readily accomplished by ceiling or plastering directly on the floor joists; but if the roof of the storage room is also the roof of the building, the roof boards should be laid close, and a layer of lath and plaster may be added just beneath them and ceiling or lath and plaster may also be added to the lower edge of the rafters.

The storage room may be kept cool in warm weather by admitting air on cool nights, and ventilators should be provided for this purpose. A ventilator should be placed in the roof for the exit of warm air. On cool nights the ventilators should be opened to change the air. The warm air will pass out through the roof ventilator, and cool air will enter through the lower ventilators. The ventilators should be closed during the warmer hours of the day.

20. Classification of the different fruits. In treating the culture of different fruits, it is convenient to arrange them into various groups, depending chiefly upon the growth habit and size of the plant, and to a less degree upon botanical characters. To acquaint the student with botanical relations, the species belonging to the same genus are generally treated together, and their common characteristics, so far as they have a cultural importance, are noted.

The three principal groups to which the fruits treated are referred are:

1. The tree fruits, including the fruits grown on trees or the largest shrubs.

2. The grape.

3. The small fruits, including those grown on small shrubs or low herbaceous plants.

SUMMARY OF THE PRECEDING CHAPTER

1. Fruit-growing in the United States and Canada is tending to become a business by itself, rather than to remain an adjunct to the farm (2).

2. Fruit growing requires education along two distinct lines, viz.: the raising and the selling of the fruit (3).

3. The outlook for commercial fruit growing is as good as for any other branch of productive industry (4).

4. The choice of a location for commercial fruit growing should be governed chiefly by the favorableness of the soil and climate, and the opportunities for marketing the fruit (6).

5. Success in commercial fruit growing will depend much upon the selection of the proper varieties of the fruits grown (7).

6. It is commonly best to purchase stock for planting from a grower rather than from a middleman, and as near the place where it is to be planted as possible. It is generally wise to order early (9).

7. A wind-break, properly grown, is beneficial to a fruit plantation not already protected from prevailing winds (10).

8. The fruit grower should provide apparatus for combating harmful parasites and diseases, and should be watchful for their appearance (12).

9. With a fruit in its proper locality, fruitfulness probably depends more upon variety than upon outside conditions (13).

10. Owing to the self-sterility of many varieties, more than two rows of the same variety should not, as a rule, be planted together. Varieties that bloom at the same time should be planted adjacent (14).

11. Fruit packages should be provided early to avoid delays in harvesting (15).

12. Every package of good fruit should be branded with the name and address of the grower (15).

13. The degree of ripeness at which fruit should be picked depends upon the use for which it is intended (16).

14. Fruit should be graded and uniformly packed (17).

15. A packing and storing house is needed where large quantities of fruit are grown (18).

SUGGESTIONS FOR LABORATORY WORK

1. Ascertain the different kinds of fruits and nuts that are grown commercially in the vicinity of your school or college; also the most successful varieties of each.

2. Ascertain the different kinds of fresh fruits and of nuts that are sold in the local market near your school or college, and where each sample seen was grown.

3. With the aid of a railroad map, locate the place in your state or territory that offers the best transportation facilities for marketing fruit.

4. If a topographical map is available, ascertain the locality in your state or territory that would seem to offer the best location for fruit growing, independent of market considerations.

5. Select the best location for a fruit farm in the vicinity of your school or college.

6. Practice nailing up the different kinds of fruit packages to acquire dexterity in the work.

7. Study the methods of packing illustrated by the fruits exposed for sale in your local market, and observe which methods appear most satisfactory.

CHAPTER II

TREE-FRUIT OR ORCHARD CULTURE

Section 1 — General Statements

21. Orchard — Definition. Tree fruits are commonly grown in orchards. An orchard is an inclosure or plantation of trees or large shrubs intended to produce fruits or nuts.

22. Orchard sites. Of the considerations previously mentioned regarding the location of the fruit plantation (6), those relating to freedom from frost and disastrous winter freezing are perhaps most important in locating the orchard. A site sufficiently elevated to give good air drainage, and sloping if at all, away from the warmest sunshine, is most favorable for the orchard unless it is near a large body of water. In the latter case the ground should generally slope if at all, toward the water, regardless of the direction.

A young orchard should not, as a rule, be planted on ground from which an old orchard of the same kind of fruit has recently been removed.

23. The class and age of trees to buy. Fruit trees are generally graded as *first* and *second class*, the first class trees being straighter and more symmetrical than the second, and commonly selling at a higher price. Unless one can see the trees before purchasing, it is safer to order those of the first class. Where both classes are equally healthy and free from insects, however, the best-rooted second-class trees of a given size will often give as good results in the orchard as those of the first class, for the irregularities of the stem and branches may be corrected by pruning.

As a rule, rather young trees, provided they are large enough to endure isolated planting, are preferable to older ones, because they can be dug more cheaply and with less damage to the roots, they can be transported and planted more cheaply, possess greater vigor, can be more readily pruned to an ideal type, and their first cost is usually less. While such trees may begin fruiting a little later than older ones, they are more likely to prove enduring, because they commonly develop in a more nearly normal manner.

Nursery trees are usually graded by size rather than by age, and the size is not a sure index of the age, since some varieties and some individuals of the same variety grow faster than others. In a given variety, the individuals that develop at a medium rate are probably preferable for fruiting to those that develop fastest or slowest.

24. The health and cleanness of nursery trees. Nursery stock is liable to infection, both in roots and tops, with injurious insects and diseases, and destructive parasites are sometimes disseminated with such stock. The seller should be required to show certificate that his stock is apparently clean and healthy. Many countries now have laws requiring the inspection of nursery stock, and certificates of such inspection may generally be accepted as evidence that the stock covered by them is safe for planting.

25. Soil preparation for orchards. If the land is well drained, and free from stumps and stones, little special preparation will be necessary unless it is designed to irrigate, in which case some grading may be required. The soil should be in a moderate condition of fertility, and should be prepared for the trees by being well plowed and harrowed.

Land with a compact or impervious subsoil should be deeply plowed. A thorough subsoiling will often prove beneficial for deep-rooting trees, as pears. The soil of the plat should be rendered as nearly uniform as possible so that the whole area may receive the same after-treatment. Land that has been some time under tillage is generally preferable to sod, though the latter may be used if the ground was well subdued when seeded.

26. Laying out orchards. The trees are usually planted either in *squares* or *triangles* (quincunx). The latter method of planting admits a larger number of trees per acre with the same distance between the trees. Straight rows in the orchard should be insisted on, and may be attained with a little care. Procure a strong, firmly-woven cord, not less than one-fourth inch in diameter, and as long as one side of the orchard, or less if the orchard is very large. Having stretched this line firmly to take out its elasticity, tie bits of red yarn tightly about it, at the exact distance the trees are to be planted apart. On a dry, still day, stretch this line tightly along one side of the plat to be planted, to mark the first row, and drive a stake at each red mark on the line. Then, if the trees are to be planted in squares, place the line exactly at right angles to this row, at one end, and mark off in a similar way the distances at which the rows are to be apart. Next mark the third side parallel to the second, after which, placing the line between corresponding stakes on opposite sides of the plat, insert the intermediate stakes in the same manner.

The triangle method is a little more complex, since the rows are nearer together than are the trees in the row. The first row may, however, be laid out exactly as described above. Then tie a cord to the first stake at one

end of the row, stretch it to the second stake and tie a short stake into the line at the exact distance of the second stake, to serve as a marker. Now describe the segment of a circle

FIG. 1. Method of laying out orchards by the "triangle" or "quincunx" system.

on the ground with the marker, around toward the second row. (Fig. 1.) Then attach the end of the cord to the second stake and make a similar segment from this stake. The point where these segments cross (A) locates the first

tree of the second row. Mark in the same way at the other end of the first row (B), after which stretch the line and stake off the second row in the same manner as the first. The distance between the rows can now be readily measured, and the rows may then be laid off at this distance by stretching the line at right angles to the first row. The distances between the rows may be indicated on the cord by a differently-colored yarn from that used to indicate the distance between the trees. The first stake of each alternate row should be set one-half the distance the trees are to be placed apart from the end (AC). Several other good methods of laying out orchards are described in Bailey's "Principles of Fruit Growing."

27. The planting of orchard trees has been considered in detail in "Principles of Plant Culture," but an additional hint will aid in securing straight rows. To avoid losing the mark where the tree is to be set, in digging the

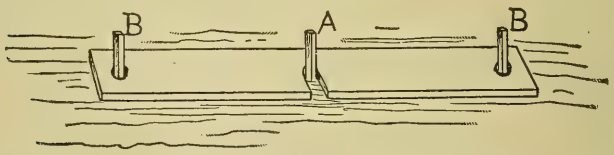


Fig. 2. Device to locate the tree after the hole is dug.

hole for it, use a short board having a notch at the center and a hole bored through it near each end. (Fig. 2.) The holes near the ends of the board should be exactly equidistant from the center of the notch, and in a straight line with it. Before digging the hole, place the board so that the stake indicating the position of the tree comes in the notch at the center (A), and put other stakes through the holes at the ends of the board (BB). The board may then be removed without displacing the end stakes, and the hole

dug, after which the board is replaced, when the bottom of the notch will mark the place for the tree.

28. The care of young orchard trees. Recently-planted trees require frequent examination. If the buds do not open promptly, the top should be further reduced. Undesirable shoots and branches should be promptly rubbed off, and close watch should be kept for harmful insects. Shading of the trunk, in trees that do not start vigorously, is important in localities where the sun's rays shine with great intensity, as in the Mississippi Valley and other central continental regions. Wire netting, straw, or screens made of lath or cornstalks may be used to protect the trees against sun-scald, damage from bark-eating animals, and in a measure from damage from whiffletrees. The lath screen (Fig. 3) is probably most durable, but it does not readily adjust itself to different heights of trunk and is too heavy for small trees. Rye straw placed vertically about the trunk and permitted to extend up among the branches, tied on by three or more bands of wool twine, makes a very cheap and effective protection that will often last as long as protection is needed. Straw protectors do not appear to harbor harmful insects. Water-proof paper answers well for winter, but should

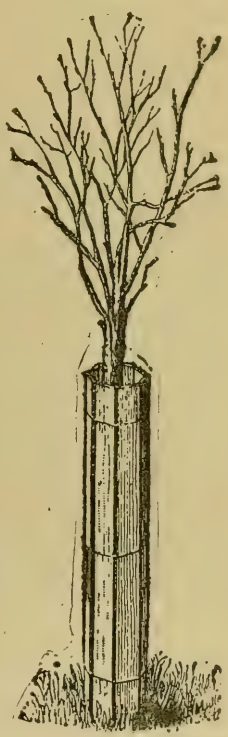


FIG. 3. Tree inclosed in lath protector.

not be left on during summer, as it is durable only when tied close to the trunk, when it harbors insects. Protectors are sometimes made of cornstalks by passing wires through them, but the labor required is probably sufficient to offset the cheapness of the material. Veneer protectors made of cheap lumber are now manufactured for sale. They are readily put on and are fairly satisfactory. Protectors made of mosquito-wire netting are effectual but not durable.

Trees of which the trunks are not strong enough to support the heads should be staked, preferably by driving two stakes on opposite sides of the tree and tying the trunk to each stake with a straw band or strip of cloth.

29. Soil treatment for orchards. Ground planted to an orchard should be used for orchard purposes primarily, and should be given the treatment that best promotes the development and fruitfulness of the trees. Cropping the orchard for the crop's sake is only admissible, as a rule, when the trees are so young that their roots do not fully occupy the ground (31).

Orchard trees in the temperate zones usually complete their season's wood growth before midsummer. The remainder of the warm season is devoted to maturing the young wood and the fruit, in forming flower buds and in preparing food for the early growth of the following year. In climates of severe winters, hardiness of the trees depends much upon complete maturity of the wood in autumn.

The soil of the orchard should, therefore, be treated to conserve soil moisture during spring and early summer, and to promote wood maturity during late summer and autumn. Tillage should usually begin early in the spring,

and continue until the close of the growth period. It may continue somewhat later with entirely hardy trees, but where the trees are liable to winter injury, moderate drying of the soil should be encouraged in late summer and autumn. In regions where irrigation is practiced, this is readily accomplished by withholding water. In other localities, dryness of the soil may be promoted by ceasing cultivation and sowing a "cover crop."

30. Cover crops are useful (a) in taking up excessive moisture from the soil late in the season, (b) in preventing wash and loss of fertility during fall, winter and spring, (c) in preventing deep freezing of the ground in winter, (d) in hastening drying of the ground in early spring, and (e) in supplying the soil with humus and sometimes with nitrogen. A cover crop should be sown, as a rule, about midsummer, or as the normal growth period ends. The leguminous crops are useful as cover crops on soils deficient in nitrogen, since they enrich the soil with this element; but on rich land on which trees tend to grow very rapidly, a cover crop that adds no nitrogen to the soil is preferable. The particular cover crop to be selected will depend upon the season, the climate and the physical condition of the soil. In dry seasons and climates, and on land not in the best condition, the larger-seeded crops will usually prove more reliable than the smaller-seeded ones. In all cases, a sufficient amount of seed should be sown per acre to furnish growth enough to make a good mat of herbage over the soil at the beginning of winter.

Of the nitrogen-gathering cover crops, the clovers, cow peas, vetches, peas and beans are available.

Of the non-nitrogen-gathering cover crops, rye and other cereals, buckwheat, millet, turnips and rape may be used.

31. Cropping orchards. If the trees of the orchard are planted at the proper distance apart, their roots will not use the whole area for forage the first few years after planting. The unused portion may, therefore, be devoted to such other crops as tend to improve, or at least which do not injure, the physical condition of the soil, provided sufficient plant food is added to maintain fertility. The more the land inclines to drought, the less should it be cropped. An area at least six feet across should be left unplanted about each tree the season following the tree planting, and this area should be considerably extended each subsequent year, for the roots of fruit trees spread rapidly. When the orchard begins to fruit well, further cropping should be discontinued, as a rule. In general, only low-growing, annual crops, that demand good tillage but not high manuring, and are harvested early, should be grown in the orchard. One or two rows of strawberries or other small fruits, planted between each two rows of trees the same season the trees are planted, may be admissible, but as a rule, early potatoes, beets, carrots or peas would be preferable. Grain and hay crops extract too much fertility and moisture. Sod in the orchard is especially objectionable, as it promotes drouth and favors insects.

Over-vigorous and tardy-fruiting young apple and pear orchards may sometimes be rendered fruitful by seeding the land to grass, but the sod should not be permitted to remain until the trees become unduly checked. In case of such seeding, it is much better to pasture the orchard than to remove a crop of hay.

32. The kind of tillage practiced should depend upon conditions. Young orchards, in which the ground was not in the best mechanical condition when planted, are

preferably plowed rather deep once each spring as early as practicable, for a few years, except near the trees, to encourage deep rooting, to thoroughly mix and crumble the soil and to retain as much soil moisture as possible. Tillage later in the season may be given with the harrow or cultivator. As a rule, the entire surface soil should be stirred once each ten days or fortnight while the tillage lasts; but if the growth of the trees is excessive, to the detriment of fruitfulness, tillage may be less frequent. The cut-away or spading harrow is excellent for keeping clay soils loose, and may be used after heavy rains. The spring-tooth harrow or clod crusher answers well for lighter soils, or after moderate rains on heavy soil. The smoothing harrow is excellent for stirring and leveling the surface and for maintaining a fine dirt mulch. All of these tools should be provided when practicable. Where cover crops are grown an annual spring plowing is necessary, but the depth of plowing may be reduced as the soil becomes subdued.

All precautions should be taken to avoid injuring the trees. Harnesses without metal projections, and short, padded whiffletrees are preferable. Special orchard harnesses that use no whiffletrees are now made, and are excellent for orchard tillage. The plow should be turned out two or three feet from the trunk of a tree. A single-horse plow with a set-over beam is excellent for use near the tree trunks.

Tillage beneath trees with low tops may be accomplished by spreading the halves of a double harrow or cultivator with a long doubletree.

33. High or low heading of trees. Very high-headed trees are objectionable for several reasons:

(a) The leverage of wind upon the trunk, and the danger of breaking down in storms are greater than in low-headed trees.

(b) The expense of gathering the fruit is greater.

(c) The damage from windfalls is greater.

(d) The expense of spraying and pruning is greater.

Very low-headed trees are also objectionable for the following reasons:

(a) The difficulty of working the soil about them is greater than in high-headed trees.

(b) The circulation of air among the branches is hindered, which results in increased damage from fungous diseases.

Low heading was formerly advocated as a means of preventing sun-scald, but this can be better accomplished by shading the trunk.

As a rule, a head of medium height — four to five feet — is preferable for standard trees. The dwarf varieties of the plum and cherry may be headed somewhat lower.

34. Principles of pruning orchard trees. The general principles of pruning are discussed in "Principles of Plant Culture," but a few points that apply especially to fruit trees are here added.

1. Before attempting to prune a fruit tree, the pruner should acquaint himself with the fruiting habit of the species: *i. e.*, the parts of the tree that produce the flowers and fruit.

2. The pruning should be such as to encourage, as far as possible, the normal development of the fruiting parts.

3. Rapid growth and fruitfulness are generally opposed to each other. The parts of the tree that grow fastest, therefore, usually produce least fruit.

4. The growth of a given part of the tree is largely determined by the amount of water it receives from the roots, and this depends chiefly upon the number of times it is diverted by branching from the axis of growth. It follows that the parts of the tree that are most times diverted by branching are most likely to form flower buds, provided they receive abundant light. Pruning should, therefore, favor branching. Vertical shoots, excepting the leader, should be discouraged. The branches should be thinned sufficiently to admit plenty of light.

5. The bud may be regarded as the unit of growth, both of wood and fruit, and the fruit tree may be regarded as two or more crops of buds of different ages, one crop of which should blossom and fruit each year, while another crop is produced to take its place. Some new wood must, therefore, be produced each year, to provide the new crop of buds. A small amount of growth upon all of the branches should be the aim.

6. Pruning should be moderate and regular. At least one careful pruning must be given each year. Spasmodic and excessive prunings, if intended to promote fruitfulness, generally do more harm than good, as the immediate result.

35. Summer pruning. As vigorous trees start growth in spring, buds often push into shoots on the trunk and branches. Such shoots on the trunk are always superfluous, and should be rubbed off before their leaves are fully expanded. They may or may not be superfluous on the branches, since they may develop into fruit spurs if allowed to remain, but they usually need thinning out more or less, and on very young trees, those forming on the inner side of the branches should generally be removed. Shoots

that incline to grow beyond the lines of symmetry should be pinched.

Proper summer pruning will greatly reduce the labor of the annual pruning. But summer pruning should be limited to pinching and the rubbing off of incipient shoots, as a rule. The removal of growing shoots after their foliage is well developed is detrimental to the vigor of the tree, since it removes the leaves that have been formed from reserve food before they have had time to restore the food they have consumed.

Branches that are dying from fungous disease, winter injury or other causes, should be removed as soon as discovered.

36. The fertilizing of orchards. However fertile and well-tilled the land may be at the beginning, the yield of fruit can hardly continue to be profitable unless fertilizing materials are added to the soil in amount corresponding to that removed in the fruit crops. Prof. Roberts has estimated that an average crop of apples removes in round numbers, 11 pounds of nitrogen, nearly one pound of phosphoric acid and 16 pounds of potash per acre. These estimates suggest how important it is to fertilize the apple orchard. We have no similar estimates for pear, plum or cherry orchards, nor for nut trees, but we may rest assured that these crops also remove large quantities of plant food from the soil.

37. How shall we know if fertilizers are needed? The trees will furnish the evidence to some extent. If these are making rapid growth, have deep-green foliage, and mature their wood well, we may infer that their needs are already satisfied. If, on the contrary, they grow slowly

[1] Bulletin 103, Cornell University Experiment Station.

the second or third year after planting, and have yellowish foliage, while being apparently free from parasites, we may conclude that their growth is being restricted by a lack of plant food, or of moisture, or both. The physical condition of the soil should be first considered. If the soil is hard and lumpy, humus should be added by growing some of the coarser cover crops, as rye or cow peas, or farm manure may be plowed in early in the spring. This treatment will probably produce the desired growth. If, as the trees reach bearing age, they are making very rapid growth and show little inclination to fruit, it may be inferred that they are receiving too much nitrogen. Non-nitrogen-gathering cover crops should then be used, and the proper balance restored by adding phosphoric acid and potash. Unleached wood ashes at the rate of 30 to 50 bushels per acre are excellent for furnishing these constituents. Leached ashes are well worth applying, since they contain nearly all of their original phosphoric acid. In the absence of ashes, phosphoric acid and potash may be purchased in various forms. The first may be had as high-grade plain superphosphate or in bone meal. The former contains 16 to 18 per cent. of phosphoric acid, and 200 to 500 pounds per acre is a good dressing for a bearing orchard. Bone meal contains about 24 per cent. of total phosphoric acid, and about 3 per cent. of nitrogen. Two hundred to 500 pounds per acre is sufficient for one application.

Potash is generally considered the most important constituent in orchard fertilizers, since fruits withdraw larger quantities of this component than of nitrogen or phosphoric acid. Nitrogen, while relatively more expensive than potash, may be provided by growing leguminous cover crops. Muriate is perhaps the best form in which

to apply potash where wood ashes are not available. One hundred to 200 pounds per acre is a good annual dressing.

When nitrogen is needed it may be directly applied in stable manure, of which a moderate dressing will usually suffice. The amounts of these fertilizers noted may be understood to apply to orchards 5 to 10 years after the trees commence bearing. As the trees attain full size the amounts may be considerably increased.

Potash and bone meal are preferably applied in the fall. The other fertilizers named are better applied in the spring before plowing.

38. Thinning fruit, *i. e.*, picking off a part of the fruit before it is full grown to enable the remainder to attain larger size, is practiced by the more progressive growers in case of the larger tree fruits. Thinning is especially important in very fruitful seasons, and in varieties that tend to overbear. The more defective specimens should be removed as soon as the damage to the fruit by its chief enemy, as the codling moth in the apple, or the curculio in the plum, becomes visible. Thinning rarely if ever increases the total yield of fruit, but it often materially increases the amount of the first-grade fruit, and it tends to prevent the harmful draft on the tree caused by an excessive crop. Thinning pays best when the fruit is grown for those markets that pay special prices for extra fine fruits. It is expensive when carefully done, but it dispenses with the cost of harvesting and marketing the part of the fruit that is sure to yield the smallest returns, while it enhances the value of the part left on the tree.

39. Picking conveniences. Various devices are needed to enable the picker to reach the fruit, the nature of which will depend much upon the height of the trees. Whatever

their form, it is important that these devices be sufficiently strong and stable, without being needlessly heavy. For trees not exceeding 12 feet in height a three-legged step ladder (Fig. 4, A) is excellent. For taller trees, a light

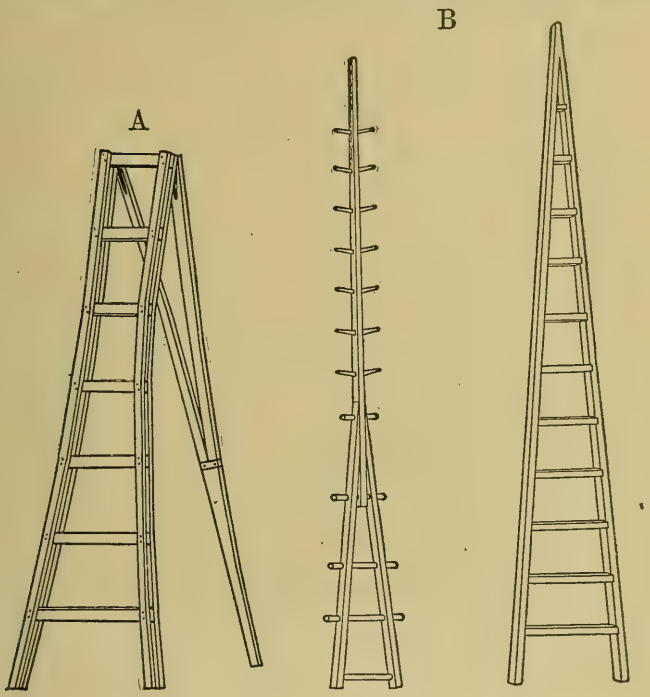


Fig. 4. Types of fruit ladders.

ladder that can rest against the branches (B) is generally preferable. Extension ladders are convenient for very high trees. Much of the fruit of tall trees may be gathered by a light and nimble person standing on the main branches. In this case, shoes should be worn that will not injure the bark.

40. Grading and packing. Orchard fruits are generally assorted after picking. This work is preferably done in a cool and dry place, and the fruit should have time to become cool before it is packed for market, otherwise it is liable to become moist in the package. The fruit is conveniently assorted on a table or counter, having a narrow board nailed edgewise about the top to prevent the fruit from rolling off. All surfaces touched by the fruit should be covered with burlap or some other soft fabric.

The number of grades made will depend much upon the kind of fruit and the general quality of the crop, as well as on the purpose for which it is to be sold. If the finest grade is intended to suit the most fastidious customers, and to rank as "fancy," only faultless specimens should be placed in it, and these should be of uniform, large size. Such fruits may often be advantageously wrapped in tissue paper, which tends to insure their arrival in the best condition. With choice samples of the larger fruits, as the finest varieties of pears, a package that gives a separate space to each individual fruit will sometimes prove a good investment.

If the quality of the fruit will not justify a "fancy" grade, the best grade should still contain only fruits fairly uniform in size and maturity, and free from insect injuries or other blemishes. Doubtful specimens should be put into the lower grade rather than the higher. Two or more varieties should never be mixed in the same package, except in grades intended for manufactured products, as for cider or evaporation.

SUMMARY OF THE PRECEDING CHAPTER.

1. An orchard site should be sufficiently elevated to give good air drainage, and should slope, if at all, away from

the brightest sunshine, except when near a body of water, when the slope should be toward the water (22).

2. First-class trees should be purchased unless the buyer can select the trees from the nursery. Trees sufficiently grown to endure isolated planting are generally preferable to older ones (23).

3. A certificate of the health and cleanness of nursery trees should be demanded (24).

4. Land for an orchard should be well prepared before planting. Land with compact soil should be deeply plowed (25).

5. The quincunx or triangle method of planting trees admits a larger number to the acre than the method of planting in squares (26).

6. The trunks of recently-planted trees should be shaded for a time in climates having intense sunshine (28).

7. The soil of the orchard should be treated to conserve water during spring and early summer, and to promote wood maturity during late summer and autumn (29).

8. Cover crops are useful in preventing washing and deep freezing of the soil, in taking up excessive moisture and in supplying the soil with humus (30).

9. Only low-growing, annual crops, that demand good tillage but moderate manuring, and that are harvested early, are suitable for growing in the orchard (31).

10. The soil of young orchards should generally be well plowed in spring, and cultivated or harrowed at least once a fortnight until midsummer. The depth of plowing may be reduced as the soil becomes subdued (32).

11. A medium height of head is most satisfactory for orchard trees (33).

12. Pruning should be moderate and regular, and above all, intelligently performed (34).

13. Fruit crops remove considerable quantities of fertility from the soil, and the orchard should be fertilized accordingly (36, 37).

14. The fruit of trees that tend to overbear should be thinned in fruitful seasons by picking off the more defective specimens while young (38).

SUGGESTIONS FOR LABORATORY WORK

1. Select the best site for an orchard on the school or college farm.

2. If a nursery is within reach, select samples of first- and second-class trees. Practice in distinguishing the different species of fruit trees by their appearance. If no nursery is conveniently located, samples of first- and second-class trees should be procured.

3. Search for parasites on the fruit trees in the vicinity, and learn the names of the different species, and which ones are most harmful.

4. Practice laying out a piece of ground for an orchard by the triangle method.

5. Compute the number of trees that can be planted, by both the square and the triangle methods, in a square field of 10 acres, the trees to be 25 feet apart both ways, and no tree to be nearer than 12½ feet to the boundary of the plat.

6. If the time is favorable for pruning, practice pruning both young and bearing fruit trees, carrying out the principles laid down in this book.

7. Practice thinning fruit if the time is right and overbearing trees are at hand.

Section 2.— The Pome Fruits

41. The pome fruits are so called from the structure of their fruit, which is a pome, *i. e.*, a fleshy fruit containing two or more carpels[1] in a pulpy expansion of the flower stem or calyx tube. The principal cultivated pome fruits are the apple (*Pyrus malus*), the imported crab apple (*Pyrus baccata*), the pear (*Pyrus communis*), the sand pear (*Pyrus Sinensis*), and the quince (*Pyrus Cydonia* or *Cydonia vulgaris*). These are trees or large shrubs, with firm, fine-grained wood. The flower buds, which are nearly or quite as resistant to cold as the leaf buds, are always terminal on the part that bears them, hence, if the part continues to live, it must branch farther back. This explains the crooked and scraggy fruiting wood of these trees. The fruitfulness of the pome fruits is commonly less regular than that of the stone fruits, where the flower buds of the latter are not injured in winter.

Productive varieties of the pome fruits often bear excessive crops alternate years, and little or no crops the intervening years. A frost sometimes cuts off the crop over a considerable section of the country, and as a result of the rest thus enforced upon the trees, the orchards bear abundantly the following season, in consequence of which the more productive varieties fail to bear the next year. The third season these trees will again bear abundantly, and the fourth year the crop will fail, and so on. This has given rise to the opinion held by some people that these fruits bear only on the odd or even year, as the case may

[1] A carpel is one of the parts of a compound seed vessel.

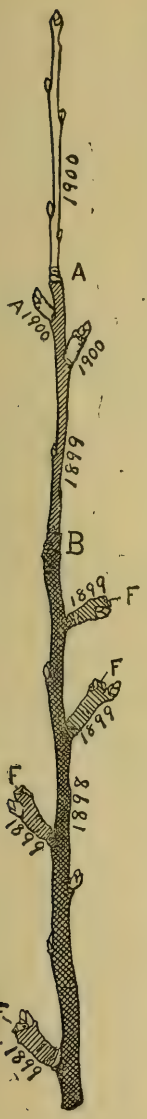
be. Thorough thinning of the fruit of the more productive varieties, when they produce excessively, tends to make them annually productive.

A — THE APPLE

42. The apple is generally regarded as the most important fruit of temperate climates. Owing to the wide variation in season of maturity of its numerous varieties, it is available in its fresh state throughout the year, and it serves a great variety of uses in domestic economy. The adaptability of the fruit to transportation, and the productiveness and longevity of the trees in favorable localities, make it the cheapest and the most widely known and used of the temperate fruits.

43. Cultural range. The apple is commercially cultivated in southeast Canada from Nova Scotia to Lake Huron, and in southwest Canada in British Columbia. In the United States it is more or less grown north of the 35th parallel, except in the arid regions of the west, and north of the 45th parallel in the Mississippi valley and Great Lakes region. The hardier crab apples succeed somewhat farther north than the common apple.

44. Fruiting habit and pruning. Figure 5 shows a twig of a bearing apple tree as it appears in winter and early spring. Let us suppose that the part from the apex to A grew during the spring and summer of 1900, a bud forming in the axil of each leaf. Then the part from A to B, except the part immediately below the upper buds, grew in 1899, and the part below B except the short branches, grew in 1898. These branches grew in 1899, forming flower buds F, which opened in the spring of 1900, and as



these flowers were terminal on the branches that bore them, the latter could grow no farther. They would have perished back to the main stem after maturing their fruit, had there not been a bud beneath the flower to continue the growth (41).

It is evident from the figure that the buds that expanded into flowers in the spring of 1900 were two years old, *i. e.*, they flowered at the beginning of the third year of their life. Their development as axillary buds commenced in the spring of 1898. Buds in the apple do not often flower younger than this. The lateral buds which do not push into shoots may form embryo flowers the second summer of their life; they often do not, however, until the third or fourth summer. If the tree is not pruned to admit sufficient light, many of the buds will never form flowers.

The further development of the fruit branches (spurs) is shown in Figs. 6 and 7. In the right part of Fig. 7 is shown a fruit spur that pushed into growth as the result of too severe pruning of the main branch beyond it. This spur was changed to a shoot, and might not have fruited again.

Since the fruit spur in the apple must branch every time it flowers, each flowering brings its buds in less direct connection with the axis of growth, hence fruit on the older spurs will receive less water than that

Fig. 5. Twig from bearing apple tree.

on the younger, and so will commonly attain less size (34). It is probably wise, therefore, to prune off the oldest fruit spurs, as the trees reach full fruiting age. Old trees that have lost their vigor from the formation of too many fruit spurs may be renovated, if still sound, by pruning that is

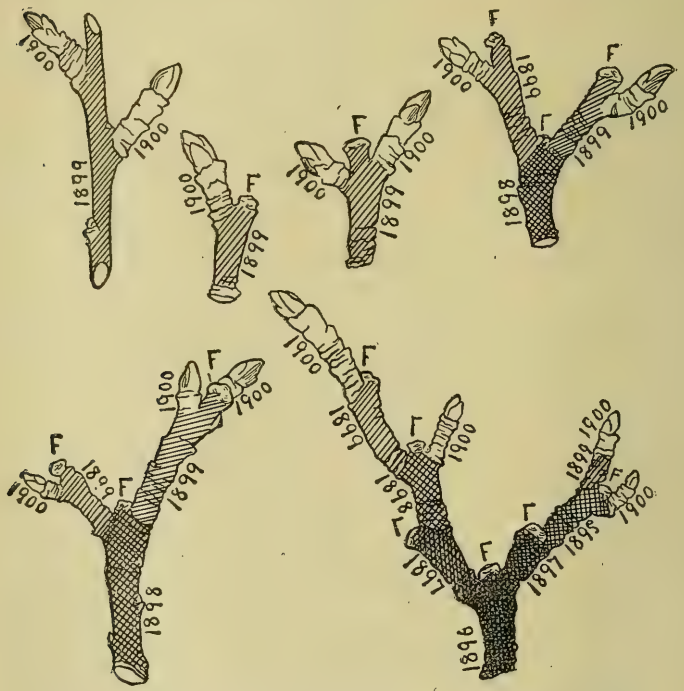


FIG. 6. Fruit spurs of apple showing successive stages of development.

sufficiently severe to start new growth from the older branches.

Age at which fruiting begins. Apple trees begin to fruit at from two to ten years from the time they are planted

in the orchard, the interval depending much upon the variety, and to a less degree upon soil and other conditions. The Oldenburg, Wealthy and Haas are among the earlier varieties to fruit, while the Golden Russet, Northern Spy and Yellow Bellflower commence fruiting late.

45. Soil for the apple. While the apple tree is adapted to a considerable variety of soils, it has generally proved most productive and enduring on deep, rich, well-drained clay loams. The presence of a considerable quantity of lime in the soil has been regarded as important by many writers.

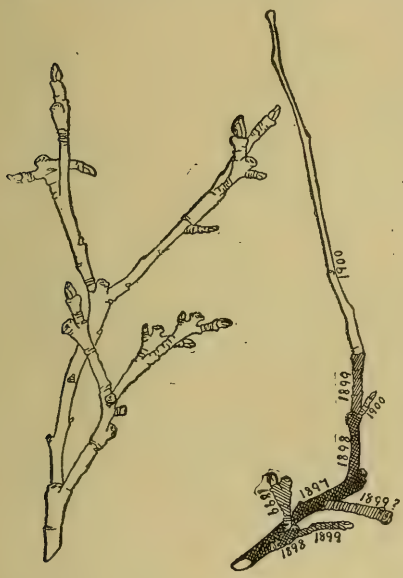


FIG. 7. An old and much branched fruit spur of the apple is shown at the left. A fruit spur that has resumed growth, becoming a shoot, is shown at the right.

46. Propagation. In the temperate zones, varieties of the apple are propagated almost exclusively by grafting[1] on stocks grown from seed, and the seed used should be taken from hardy and vigorous trees. If seedlings are grown from seeds from cider-mill pomace made from mixed apples, only the most vigorous ones should be grafted. The seedlings are usually taken up the

[1] Budding, by which many apple trees are propagated in some sections, is one form of grafting. For detailed directions for grafting, see "Principles of Plant Culture."

autumn after the seed was sown and heeled-in, or packed in boxes with fine moss. They may then be buried in a well-drained place in the open ground, or stored in a cool cellar. They may be root-grafted the following winter, or planted out in nursery rows the following spring, to be budded during the summer or top-worked at a later time.

Root-grafting with long cions, on short sections of root, is generally preferred to budding in climates having hot and dry summers and severe winters. Under these conditions the root grafts are more likely to grow than inserted buds, while the stock, being placed rather deep in the soil, is less subject to winter-killing if tender, than when worked above ground. Budding, on the other hand, is more practiced in mild climates, because it is regarded a cheaper mode of propagation.

Dwarf stocks for the apple. The apple tree may be dwarfed by working it upon what is known as Paradise and Doucin stocks. These are dwarf varieties of *Pyrus malus* that are native to parts of Europe. The former produces the shorter and earlier-bearing trees. Dwarf trees are valuable for testing new varieties and for growing upon small grounds, and are much admired by some amateurs. They usually begin to bear in two or three years after grafting, and at five or six years of age often yield a bushel or more per tree. Trees worked on Paradise stock are so dwarf that the highest fruits may usually be picked by hand from the ground. Dwarf apple trees have not been found profitable in America for commercial orchards.

47. Age and distance for planting. Apple trees are commonly planted in the orchard in the northern states, at three years from the root graft or budded nursery tree. Some rapid-growing varieties become large enough at two

years from the graft or bud while slower-growing sorts are preferably allowed to grow four years in the nursery. Old and overgrown nursery trees should be avoided (23).

Standard apple trees expected to attain full size should be planted not less than 30 feet apart and in localities in which the trees grow with much vigor, they should be planted not less than 35 feet apart.

48. Harmful parasites. The principal insects that injure the fruit of the apple in America are the codlin or codling moth, the apple maggot and the apple curculio; those that injure the foliage are the tent caterpillar, plant lice, the canker worms and leaf-rollers; those that injure the trunk or branches are the apple-tree borers, the oyster-shell bark-louse and the San Jose scale; and the one most injurious to the roots is the woolly aphis. Of the fungi, the apple scab and bitter rot affect the fruit, the fire blight and the apple scab affect the foliage and young twigs, and the apple canker affects the branches. These are considered in their order.

49. The codling moth, (*Carpocapsa pomonella*). This insect causes so-called wormy fruit in the apple and pear (Fig. 8). It is one of the most serious of fruit insects, as fruits infested by its larvæ have little value either for market or home use. In seasons of small crops, nearly the entire yield of fruit is often damaged by this insect unless preventive measures are used. It was imported into this country from Europe and is now found in nearly all parts of the United States and Canada east of the Rocky mountains.

The perfect insect is a moth that flies mostly at night (g, Fig. 8). The first brood of moths appear about the time the blossoms open, when the female deposits her eggs, usu-

ally in the calyx of the young fruit but sometimes on other parts of the fruit or upon the leaves. The egg hatches in a few days and the larva proceeds to eat a passage to the core of the young fruit, pushing its castings out behind it and enlarging the channel from time to time. The reddish-brown castings usually adhere more or less about the entrance of the opening. The larva (e) feeds on the interior of the fruit during three or four weeks or until it attains full growth, when it leaves the fruit and seeks a secluded place for pupation, which it usually finds under the rough bark or in cracks and crevices about the trunk of the tree. The injured fruit generally falls from the tree before, or soon after the larva leaves it. In about two weeks (about mid-summer), the moth escapes, after which it deposits eggs for a second brood.

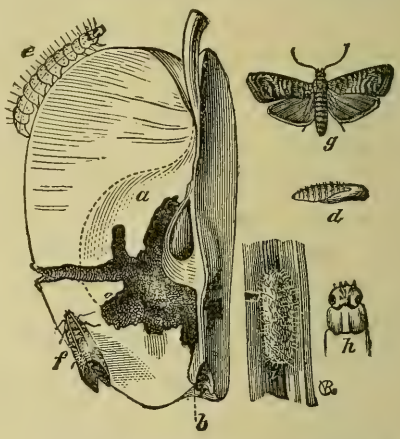


FIG. 8. Codling moth, and its work in the apple. A, burrow of larva; b, point where larva entered; d, chrysalis: e, full-grown larva (the apple "worm"); f, moth with wings folded; g, moth with wings spread; i, cocoon. (After Riley.)

The early and later broods are not sharply defined, but overlap more or less, so that the larvæ of the early brood may not all have left the fruits at the time some of the second brood are hatched. The larvæ of the second brood become full-grown during autumn or early winter and often do not escape from the fruit until after it is harvested. They may remain in the fruit during a considerable part of the

winter, often escaping in the cellar or storage house where they spin their cocoons in concealed places, from which the moth emerges the following spring.

Preventive measures. Spraying the trees shortly after the petals fall and while the calyx of the young fruit faces upward, with water containing Paris green at the rate of one pound to 200 gallons destroys many of the young larvæ as they attempt to eat their way into the fruit. As the egg-laying period for the first brood continues several days, and as the young fruit expands rapidly at this period, a second spraying should be given 7 to 10 days after the first, and if rains are frequent, a third spraying after a like interval is advisable.

In addition to spraying, bands about 6 inches wide of burlap, old carpet, other cloth fabric, or of building paper, should be placed about the trunk of the trees to entrap the larvæ as they search for a place to transform. The bands should be put on about June 1st, and should be wound once or twice about the trunk, when the end may be fastened with a tack or cord. The bands should be taken off every 8 or 10 days until September, and all larvæ or chrysalids found beneath them should be destroyed, after which the bands should be replaced. They should also be removed once after the later apples are harvested. The cocoons are often torn open in removing the band, permitting the larva to drop to the ground. The larva should then be killed so that it will not form another cocoon. Finally, all fruit that falls from damage inflicted by the codling-moth larva should be promptly destroyed. Hogs or sheep in the orchard aid greatly in this work. In the absence of these, the fallen fruit should be gathered daily and fed to stock or otherwise disposed of to destroy the larvæ they contain.

50. The apple maggot (*Trypeta pomonella*), where it abounds, is often more destructive than the codling moth, as it renders the fruit worthless for any purpose except stock feed. It is most destructive to apples grown on sandy soil, in cultivated orchards, and to early varieties. It does not always betray its presence in the fruit by conspicuous external marks, hence infested fruit is often marketed, and thus the insect is spread to new localities. Fortunately it does not spread readily from tree to tree, and hence is not likely to become generally disseminated.

The infested fruits generally ripen and fall prematurely and the larvæ do not escape until the fruit has fallen, hence by promptly destroying all fallen infested fruits, this insect may be kept in subjection. Hogs and sheep in the orchard greatly aid this work.

51. The apple curculio (*Anthonomus quadrigibbus*), injures apples greatly in some localities by stinging and eating the fruit, making it ill-shaped and under-sized. The beetle feeds considerably upon the young fruit, making, however, only a puncture through the skin. As the larva escapes from the fruit while the latter is attached to the tree, it cannot be destroyed by hogs or sheep. Jarring the trees over sheets, as described for the plum curculio, (99) and spraying as described for the codling moth (49) are most likely to prove effective treatments.

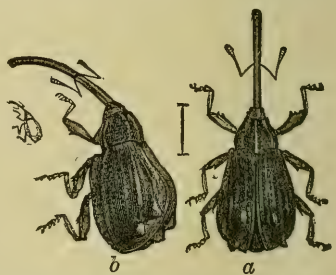


FIG. 9. Apple curculio. A, back view; b, side view, both magnified; natural size shown at left. (After Riley.)

52. The tent caterpillar (*Clisiocampa Americana*), forms the conspicuous tent-like nests upon the branches

of apple trees in May or June, from which the numerous caterpillars sally to forage on the neighboring foliage (Fig. 10). The nests should be destroyed before fully formed by rubbing them off in the morning or evening with a pole, bearing at the end a swab of cloth wet with kerosene to kill the young caterpillars. The rather conspicuous egg clusters (Fig. 11), which are deposited on the young limbs, may be destroyed while the trees are leafless.

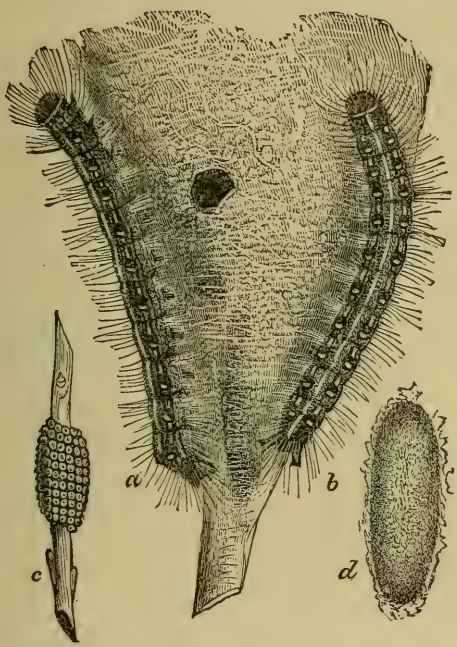


FIG. 10. Tent caterpillar. A, side view; b, back view; c, egg cluster with gummy covering removed; d, cocoon. (After Saunders.)

53. Plant lice (*Aphidae*). These troublesome insects injure the foliage of the apple and of nearly all other fruit trees by sucking the juices from the leaves. They chiefly infest the lower side of the leaves and are most troublesome in early summer. It is difficult to apply an insecticide to the lower surface of the leaves, and the insects being more or less protected by the curling of the leaves about them, are not easily controlled after the foliage has fully expanded. The buds should be examined

when they are beginning to open in the spring, and if infested with numerous plant lice, the tree should be sprayed with kerosene emulsion.[1] The leaves being upright are then easily reached with the emulsion and a small amount is sufficient to wet all of the buds. Should the insects become numerous later, repeat the spraying, applying it with force, taking care to wet the under side of the leaves as far as possible. The operator should stand near the trunk of the tree and direct the stream upward and outward.

FIG. 11.[2]

54. Canker worms (*Anisopterix*). Two species of canker worm infest apple trees, but both are amenable to the same treatment. The eggs hatch about the time the leaf buds expand and the young caterpillars, which are of the class known as "measuring worms," feed on the foliage. They are readily destroyed by spraying with water containing Paris green at the rate of a pound to 200 gallons.

55. Leaf rollers (*Cacœcia*). One or more species of leaf rollers feed on the foliage of the apple tree in spring and early summer. These are often very injurious, sometimes almost defoliating neglected trees. The treatments recommended for the codling moth (49) will usually prevent serious damage from these insects.

56. Various other insects attack the foliage of the apple, but fortunately most of these are active early in the season, when they may be destroyed by the spring sprayings. A few, however, need attention at other times. Late in summer the caterpillars of cecropia moths (*Samia*); of the yel-

[1] For directions for making and applying the kerosene emulsion, see "Principles of Plant Culture."

[2] Egg cluster of tent caterpillar attached to twig of apple tree. (After Saunders.)

low-necked apple-tree caterpillar (*Datana ministra*), and of the red-humped apple-tree caterpillar (*Oedemasia concinna*), often do much damage, especially to young trees, by consuming the foliage. They may be destroyed by spraying with water containing Paris green, as heretofore directed. During winter the cocoons of the cecropia moths and of the apple-leaf crumpler (*Physis indigenella*), are conspicuous on the branches, and should be picked off and destroyed.

57. The round-headed apple-tree borer (*Saperda candida*) injures the trunks of the apple, pear and quince. The perfect insect is an attractive beetle (c, Fig. 12). The female

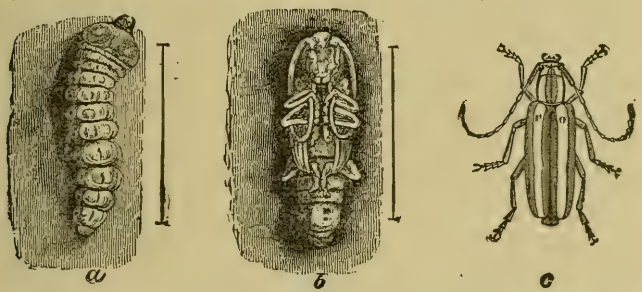


FIG. 12. Round-headed apple-tree borer. A, larva as it appears in tree; b, chrysalis (both slightly enlarged); c, mature insect (natural size). (After Saunders.)

deposits eggs late in June and during July on the bark of the tree near the ground. These hatch within two weeks, when the larvæ at once begin to eat their way through the bark. The insect is thought to remain three years within the trunk before the beetle emerges. The first season is supposed to be passed in the sap wood and inner bark, where the larva forms shallow cavities an inch or more in diameter, over which the bark often becomes dark-colored and cracked. The next season, the larva continues to eat

the sap wood, to which it does great damage, and if several borers chance to be in the same tree, they may completely girdle it. The third season, the larva (a) eats into the heart wood, and the following spring escapes as a perfect beetle.

Preventive measures. Examine the trunks of the trees near the ground late in August or early in September, when the presence of the young larva may often be detected by discoloration of the bark over it. It may then be cut out with a pocket knife and destroyed. Later, little heaps of brown castings on the ground may betray the presence of the insect, which may then often be destroyed by probing the burrow with a stout wire or a flexible twig, or by cutting through the bark at the upper end of the chamber and pouring in scalding water.

Soft soap, reduced to the consistency of thick paint with a strong solution of washing soda, applied to the whole trunk early in June, often prevents egg deposit. If applied on the morning of a warm day, the coating soon dries and is not easily washed off. The application should be renewed in the early part of July. Removing the earth two or three inches deep about the base of the trunk, and painting the bark thus exposed heavily with common paint is said to keep out the larvæ. This preventive should be used only on trees of considerable size. Inclosing the trunk with wire mosquito netting is also said to be effectual.

58. The flat-headed apple-tree borer (*Chrysobothris femorata*) is also very troublesome to trees of the apple, pear and quince. This insect may infest any part of the trunk and sometimes even the larger branches. Its mature form is a beetle, three-eighths to half an inch in length (d, Fig. 13). Its eggs are deposited under the loose bark

scales, or within cracks and crevices of the bark. These soon hatch and the young larva eats its way into the sap wood, where it excavates broad channels. A single specimen will sometimes girdle a small tree. The insect is supposed to pass its transformations in one year.

Preventive measures. The trees should be examined in early fall for this insect, when the young larva, if present, may often be detected by discoloration of the bark, by a flattened or dried appearance of the bark over its burrow, or by the presence of sawdust-like castings adhering to the bark. The larva (a, Fig. 13) may be cut out with a knife, or the burrow may be probed with a wire or flexible twig. Coating the bark with the soap mixture previously recommended (57) aids in preventing the entrance of the larva.

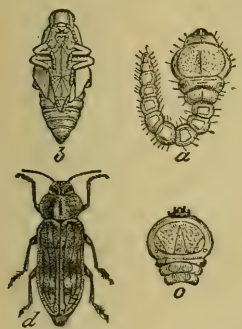


FIG. 13. Flat-headed apple-tree borer. A, larva as it appears in tree; b, chrysalis; d, perfect insect. (After Saunders.)

The flat-headed borer is most likely to attack trees of which the bark has already been injured by sun-scald or otherwise.

59. The oyster-shell bark-louse (*Mytilaspis pomorum*) (Fig. 14) affects the apple, pear and quince fruits throughout northern United States and Canada. It is most injurious to unthrifty trees. The scales, which cover the eggs of the insect, are about one-sixth of an inch long. They are colored like the bark and are shaped somewhat like an oyster shell. They are mostly attached to the smooth bark of the younger branches and are sometimes so numerous as to almost conceal the bark. The eggs hatch late in May or early in June, when the lice, which are so small as to

appear to the unaided eye as mere specks, leave the scales and scatter themselves over the twigs and foliage of the tree, subsisting on its juices. Later they largely congregate about the base of the side shoots of the terminal twigs, where they gradually secrete the scale beneath which the eggs are deposited, and remain until the following spring.

Preventive measures. Potash dissolves the scales, and kerosene destroys both the eggs and the lice. By spraying before the leaves appear in spring with a kerosene emulsion containing an abundance of soap, the great majority of the eggs will be destroyed. Watch should be kept during the latter part of spring for the appearance of the young lice. If these hatch in large numbers a second spraying with the same material should be given. Unthrifty trees should be restored to vigor by improved cultivation, manuring or stimulative pruning, as is most needed. Often the restoration of vigor removes the greater part of the lice. Young trees infested with bark-lice should not be planted unless treated with the kerosene emulsion.

FIG. 14.[1]

60. The San Jose scale (*Aspidiotus perniciosus*) (Fig. 15) is a minute scale insect destructive to nearly all fruit trees and plants grown in the United States and Canada. On much-infested branches, the scales appear as a grayish, slightly roughened, scurvy deposit which, when crushed by scraping, yields a yellowish, oily liquid. Affected twigs examined with a good hand lens during summer show orange-colored larvæ running about, and snow-white young

[1] Oyster-shell-bark louse as it appears on twig of apple. (After Saunders.)

scales interspersed with brown or blackened mature scales. The larvæ are produced in successive generations from spring until autumn frost, and multiply with extreme rapidity. The San Jose scale is chiefly disseminated by nursery stock. (24)

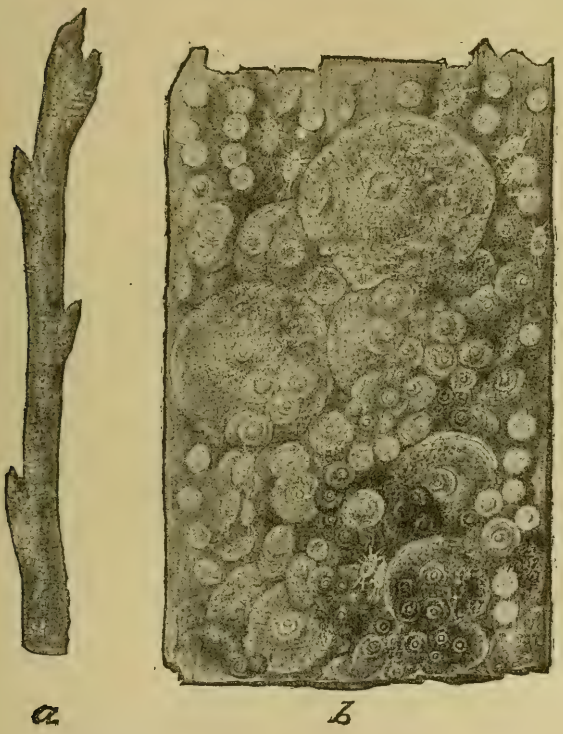


FIG. 15. San Jose scale. A, natural size; b, enlarged. (After Howard, U. S. Department of Agriculture.)

Preventive measures. Infested nursery stock is best freed from the San Jose scale by fumigating it in close rooms,

with hydrocyanic gas.[1] Infested orchard trees may be sprayed in winter with a solution formed by dissolving two pounds of whale-oil soap in one gallon of hot water; or with undiluted crude petroleum of a specific gravity of not less than 43° Beaume. A single spraying is not likely to destroy all of the insects on a badly infested tree, hence it is often necessary to repeat the treatment the following winter. Summer sprayings may be made with strong tobacco water or a mechanical emulsion containing ten per cent. of kerosene.

61. The woolly-louse or woolly-aphis of the apple (*Schizoneura lanigera*) (Fig. 16) is injurious in two forms, in one form attacking the trunk of the tree, and in the other the roots. Both forms infest apple trees of all ages. In spring the presence of the insect is indicated by small bluish-white specks resembling mold, about the base of the shoots growing from the trunk, about the base of the trunk itself, or about recent wounds in the bark. Later, the cottony coating of the insect becomes more distinct and adheres to the fingers when touched. In autumn, the insects commonly cluster about the axils of the leaves toward the end of the twigs, sometimes appearing in such numbers as to make the tree look as if whitewashed. The lice derive their nourishment from the sap of the tree and

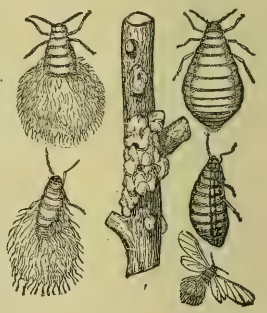


FIG. 16. Woolly-louse of apple. (Cut from U. S. Department of Agriculture.)

[1] The method of preparing this gas is described in "Principles of Plant Culture." The trees are exposed 45 minutes to the gas formed by mixing 1 fluid ounce each of sulfuric acid and fused potassium cyanide (98 per cent. pure) with two fluid ounces of water for each 125 cubic feet of space in the fumigating room.

the numerous punctures thus made cause wart-like excrescences on the bark. In cases of severe attack the leaves turn yellow and drop and sometimes the trees die.

The winged females, which appear in autumn, fly from tree to tree to deposit eggs for another generation the following spring. The lice can endure considerable frost, and in mild climates pass the winter about the base of infested trees. This form of the insect is readily destroyed by two thorough sprayings with strong kerosene emulsion, or if only the trunk of the tree is infested, by applying the emulsion with a whitewash brush to this part.

The root-inhabiting form is a more serious pest where it abounds, than the aerial form. Infested trees are indicated by pale or yellowish, scanty foliage and feeble growth. Unless relieved, they sooner or later die or blow over by the wind. By removing earth from the roots near the base of the trunk, the lice will be found in clusters about and between the roots, which have grown knotty and distorted from the continual drain upon their juices by the lice. The roots thus injured soon perish and decay, and the tree, if large, is blown down by the first hard wind.

Tobacco dust used about the roots is a specific for the root form of the woolly-aphis. Infested orchard trees may be cleared from it by removing the earth about their roots to the depth of 4 inches, and to a distance of 2 feet from the trunk, and scattering 5 or 6 pounds of tobacco dust over the bottom of this excavation, after which the dirt should be replaced. In much infested regions 2 or 3 pounds of tobacco dust should be applied each spring, to each orchard tree, as above directed, to prevent attack; nursery apple trees should have a liberal application of tobacco dust about their roots each spring, removing some of the

soil as above described, and in planting orchard trees, tobacco dust should be freely used about the roots. Apple seedlings and root grafts should be planted sufficiently deep so that they stand in a shallow trench, which should be filled with powdered tobacco or tobacco dust lightly covered with earth. Newly-cleared land should be cultivated two years before planting with apple trees, to rid it of the woolly-aphis.

62. The fire blight[1] (*Micrococcus amylovorus*) is a bacterial disease that affects all of the pome fruits. The spores of the bacteria enter at the tips of growing shoots, or through the open flowers or wounds made by insects, and the disease works its way backward, destroying the tissues as it proceeds, causing the foliage and wood to assume a blackish-brown color and to emit a characteristic odor. It affects the pear and quince more than the apple, as it progresses much faster in these fruits. The more succulent the tissue of the young growth, the more likely is it to become infested with fire blight and the more rapidly the disease progresses.

Preventive measures. Since over-succulent tissue favors infection by fire blight, stimulants to excessive growth, as thorough cultivation and heavy nitrogenous manuring should be avoided. Free circulation of air about the tree should be encouraged. Infested shoots should be cut off and burned as soon as discovered. They should be cut six or eight inches below the point of visible infection, as the dead tissue marks the points to which the disease has finished its work, rather than commenced it.

63. The scab fungus (*Fusicladium*) affects the apple and pear, causing blackish, scabby spots upon the fruit which

[1] Known also as "pear blight," "apple blight," or simply "blight."

it also reduces in size and disfigures in form and appearance (Fig. 17). It also affects the foliage and younger twigs, and sometimes the flowers, even destroying the fruit spurs in severe cases.

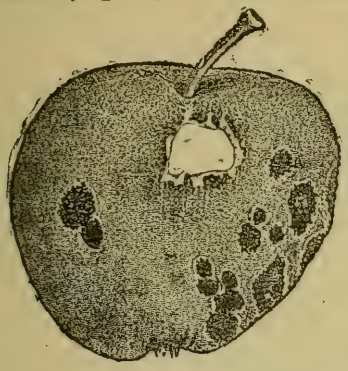


FIG. 17. Apples affected with scab (the dark spots). (After Lamson-Scribner.)

This disease is propagated from spores blown about by the wind, which germinate under favorable conditions of warmth and moisture. It is most destructive in warm and wet weather, and in locations that favor a moist atmosphere, as in densely-planted orchards or on branches that hang near the ground.

Preventive measures. The free circulation of air among the trees and branches of the orchard promotes a dry atmosphere and tends to prevent germination of the spores of the scab fungus, and to retard the progress of the disease. Spraying the foliage with Bordeaux mixture greatly reduces damage from the scab in wet seasons. The first spraying should be given before the blossoms open, to be followed by a second after the petals fall, and a third about a fortnight later. In very wet seasons, sprayings should be more frequent. Good culture, proper manuring and pruning do much to reduce damage from the scab fungus.

64. Bitter rot, also called "ripe rot" and "bird's-eye rot" (*Glœosporium fructigenum*) is a fungous disease that affects the pome fruits and the grape, especially the apple, on which it is often very destructive in south and southwest United States. It occurs as the fruit approaches

maturity and may continue to develop during storage (Fig. 18). It appears as a small, circular spot of pale-brownish tissue, slightly sunken, which increases by concentric

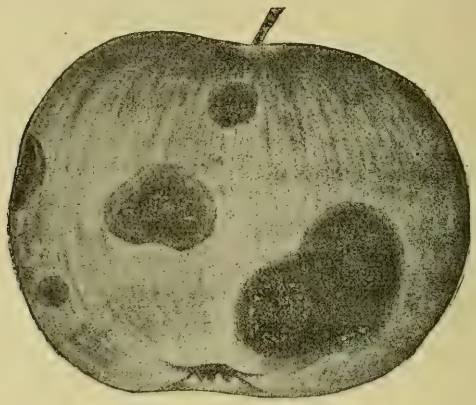


FIG. 18. Apple affected with bitter rot. (After Alwood.)

areas. The affected part, which usually has a bitter taste, becomes softened as the decay extends into the tissues.

Preventive measures. Spraying as the fruit approaches maturity, with ammoniacal solution of copper carbonate, or a solution of potassium sulfide,[1] tends to prevent this disease. Varieties specially subject to it should be discarded.

65. The apple canker, which is caused by the fungus *Sphæropsis malorum*, is common and often very destructive in orchards in the older apple-growing regions of the United States. In badly infested trees, the disease is indicated by dark and enlarged sections of the larger limbs, on which the bark is thickened and much roughened. These diseased sections are often six or more feet long. A por-

[1] For formulae for these spraying compounds, see "Principles of Plant Culture."

tion of the wood is often laid bare, but the dead bark also frequently clings tenaciously to the decaying wood. The progress of the disease may be marked by numerous pits or scars, which are usually circular in form and may be outlined by two or more concentric lines. The fungus extends down from diseased branches, or from canker spots at the forks of the tree, destroying large areas of bark and exposing the wood in ugly wounds in aggravated cases. A majority of cankers start from some mechanical injury.

The presence of the fungus in a newly infected limb is indicated by a small area of discolored bark, which extends slowly in all directions as the fungus grows.

Preventive measures. Cankered limbs should be cut out and burned wherever practicable. Thorough spraying with Bordeaux mixture at the times recommended for the scab fungus (63) tends to prevent new infection. Wounds in the bark should be promptly painted, or coated with grafting wax. Scraping the loose bark from the trunk and larger branches of bearing trees, following with a coat of whitewash tends to prevent the spread of the disease.

66. Picking and packing apples. Apples are fit to pick when the seeds have assumed a uniform brown color. The earlier varieties, when picked for a distant market, may be gathered a little before this stage. As a rule, early picking tends to long keeping.

Several devices for picking are on the market, but these are of little use except for reaching apples that cannot be reached by hand.

Apples are commonly packed in barrels holding two and three-fourths to three bushels. In some states, the size of the package is regulated by law. Choice apples of early varieties are sometimes marketed in bushel or one-half

bushel baskets and occasionally in boxes holding about a bushel (Fig. 19). When packed in barrels, the first two or three tiers of apples put in the barrel are commonly *faced*, *i.e.*, placed in regular rows with the stem end downward. The

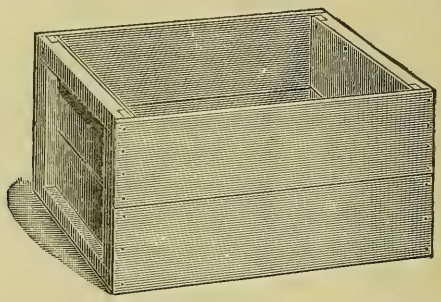


FIG. 19. A bushel box for marketing apples and pears (size 10x12x18 inches, inside).

faced apples should be of uniform size and should represent the average quality of the fruit in the barrel; they should be placed in concentric rings beginning at the outside of the barrel, and those of the second tier should be placed in the depressions between those of the first tier. When apples are packed for shipment across the ocean, it is well to face the entire barrel, as this ensures close packing and tends to careful assorting. When packed for home trade, only one end of the barrel is commonly faced. The unfaced apples may be put in with a small, swing-handled basket, that can be turned over in the barrel, and the barrel should be shaken a little as each basketful is emptied. The barrel may be filled nearly even full from the basket, and the last apples put in should project about an inch above the top of the barrel, but if the contents of the whole barrel are faced, the last tier should project but little above the top, as they are packed closer when all are faced than when

the greater part are poured in from the basket. The head of the barrel is then placed on the apples and the upper hoops driven up sufficiently so that the head may be pressed down to its place. The press is then applied as shown in Fig. 20, taking care that all parts of the head settle evenly. It is often necessary to change the bearing point of the press to accomplish this. The hoops should next be driven down to their proper place, when the head should be securely nailed by driving small nails through the uppermost hoop at such an angle that they will enter the head near its surface. For long transportation, it is well to tack a slender strip of wood inside the chine at each end of the barrel, nailing downward into the staves and against the head so as to give additional support to the ends of the latter. The head that formed the bottom of the barrel in filling is generally stenciled, and is expected to be removed when the barrel is opened, but the dealer often opens the unstenciled head, to satisfy himself as to the quality of the packing.

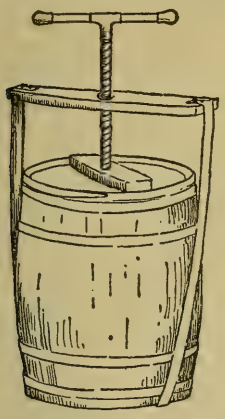


Fig. 20. Press for packing apples.

67. Influence of growth conditions on the character of apples. The season of maturity of apples, and the length of time they keep, depend much upon the climate in which they are grown. The winter apples of northern United States are autumn apples when grown farther south. Some winter apples of the northern states are early autumn apples when grown in Georgia. Many excellent northern varieties have little value farther south, and vice versa.

It is said that the flavor and keeping qualities of apples are considerably affected by the soil on which they are grown, and that apples grown on strong, heavy soils are finer in flavor, higher in specific gravity, and possess better keeping quality than those grown on lighter soils. Apples grown on healthy trees keep better than those grown on feeble, poorly-fed or parasite-injured trees.

68. The crab apple. The fruit of the crab apple is smaller, firmer in flesh, and is borne more in clusters than that of the common apple; the foliage and shoots are smoother and the shoots and fruit spurs are more slender. The tree is more resistant to the cold than that of the common apple, which adapts it to severe climates. The fruit is chiefly used for jelly, cider and preserves. Two species of the crab apple are native to the United States, but the one commonly cultivated here was introduced from Europe. The latter hybridizes freely with the common apple; some valuable hybrids have thus been obtained.

The culture of the crab apple does not differ from that of the common apple.

SUMMARY OF THE PRECEDING SECTION

1. The apple commonly fruits on short branches (spurs) from three or four-year-old wood. After the spurs have fruited once, they may fruit annually or biennially thereafter (44).

2. Old fruit spurs of the apple commonly produce small fruit because the nourishing sap must pass through so many branches. It is probably best to prune off the older spurs (44).

3. The apple tree has generally proved most productive and enduring on deep, rich, well-drained clay loams (45).

4. The apple is mostly propagated by budding or root-grafting on apple seedlings. Root-grafting with long cions is preferred in severe climates (46).

5. Apple trees are commonly planted in the orchard at three years old from the bud or root graft. If expected to attain full size, they should not be set less than 30 to 35 feet apart.

6. The codling moth, canker worms and leaf rollers may be held in check by timely and thorough sprayings with water containing Paris green at the rate of 1 pound to 200 gallons. For the first-named insect, bands of burlap placed about the trees in summer are helpful by enticing the larvæ to pupate where they may be easily destroyed; gathering and feeding out the fallen infested fruit is also helpful (49, 54, 55).

7. The apple-tree borers may be held in check by probing their burrows with a flexible twig, by washing the trunk with the soap-soda solution or by painting the trunk thickly just at the surface of the ground with common paint (57, 58).

8. The oyster-shell bark-louse may be controlled by keeping the trees in a vigorous condition, or by spraying the infested parts with a kerosene emulsion containing an abundance of soap (59).

9. The San Jose scale may be removed from nursery trees by fumigating them in a close room with hydrocyanic gas. Orchard trees may usually be freed from it by spraying them during winter with a solution of whale-oil soap or with crude petroleum (60).

10. The aerial form of the woolly-louse may be controlled by spraying with a strong kerosene emulsion, and the root form by the free use of tobacco dust about the roots (61).

11. The fire blight may be held in check in part by avoiding stimulants to rapid growth and by burning infested shoots (62).

12. The apple scab may be largely controlled by thorough spraying with Bordeaux mixture (63).

13. The bitter rot may be held in check by spraying, as the fruit approaches maturity, with ammoniacal solution of copper carbonate or potassium sulfide solution (64).

14. The apple canker may be in part controlled by cutting off and burning infested limbs, by spraying with Bordeaux mixture, by covering wounds with paint or grafting wax and by whitewashing the trunk and larger branches (65).

15. Apples are commonly marketed in barrels, baskets or boxes. When packed in barrels, the first two or three layers put in are "faced" and the filled barrel is moderately pressed (66).

16. The season of maturity, keeping period and quality of apples depend much upon the environment in which they are grown (67).

17. The crab apple resists cold better than the common apple, but it is adapted only for culinary purposes and cider (68).

SUGGESTIONS FOR LABORATORY WORK

1. Study Fig. 7, and ascertain the minimum age of the oldest part of the much-branched fruit spur, referring to Fig. 6 for the method.

2. Study fruit spurs from bearing apple trees, ascertaining the number of times each has blossomed, and the probable age of the different parts.

3. If the students have not had lessons in grafting, give

them practice in root- and top-grafting, and budding the apple, providing the time of year is suitable.

4. Study any of the insects and diseases named as harmful to the apple, of which samples can be found, and apply the preventive methods so far as practicable.

5. Practice in picking, assorting and barreling apples if the time of year admits.

6. Study the methods of assorting and packing apples as illustrated in your local market, and if possible, compare the quality of the same variety from different scurces.

B — THE PEAR

69. The pear. The finer varieties of the pear are among the most delicious of fruits. Perhaps no other fruit has been more improved by cultivation. While the finer pears may excel the apple in edible quality, the pear is of less commercial and domestic importance than the apple, owing to its narrower cultural range.

70. Cultural range. The pear is nearly as resistant to cold as the apple, but owing to its great susceptibility to fire blight (62), it succeeds well only in special locations. It is grown on a commercial scale chiefly in the part of the United States lying east of the Mississippi Valley, and on the Pacific coast. It does not succeed well in the Southern States, and is little grown in Canada.

71. Soils and sites. Since fire-blight is the chief obstacle to the culture of the pear within its climatic range, and since this disease is favored by the conditions that favor rapid growth (62), the soil and site for the pear orchard should be such as do not stimulate rapid growth in warm weather. A well-drained clay soil of moderate fertility, and a cool and airy location, should therefore be selected for the pear orchard.

72. Fruiting habit. The fruiting habit of the pear is very similar to that of the apple. The growth of the fruit spurs is apt to be a little more rapid (Fig. 21), and the buds are perhaps more likely to form flowers the first year of their life than in case of the apple. The tree comes into bearing at about the same age as the apple tree, but as it seldom attains so large a size, individual trees are not often as productive as apple trees of the same age.

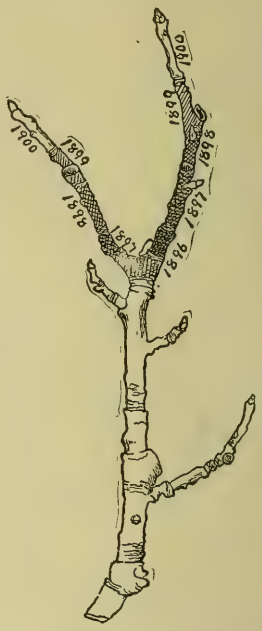


FIG. 21. Old fruit spur of pear. (Adapted from Bailey's "Pruning Book.")

73. Soil treatment and pruning. To avoid fire blight (62) the tillage of the standard[1] pear orchard should be less thorough than that recommended for orchards in general (29). Nitrogenous cover crops, and manures rich in nitrogen, should commonly be avoided, but potash and phosphoric acid may be freely used.

The pruning of the standard pear tree should be very similar to that recommended for the apple (44, 34), but it is especially important to avoid over-pruning.

74. Propagation of the pear. The best stock for standard pear trees is seedlings of their own species. The seeds should be separated from the pulp, stratified in sand and

[1] The word *standard*, when applied to a fruit tree, means that the tree is expected to attain its normal height; i. e., that it has not been dwarfed by grafting it on dwarf stock (75).

buried a few inches deep, in a well-drained place during winter, to be taken up and planted early in spring. The soil for the seed bed should be moist, deep and rich, and should contain a large amount of humus. Lime and ashes are thought to be especially useful.

The seeds should be sown thinly in drills, one to two feet apart, and the ground between the drills should be kept clean and well cultivated to avoid leaf blight (82).

Pear seedlings make few lateral roots the first season and hence are likely to be heaved out by freezing of the soil during winter. To prevent this, the ground between the drills may be heavily mulched with leaves in autumn. Mice may be kept out by surrounding the bed with a ridge of fresh earth a foot or more high.

Another method of preserving the seedlings is to bury them late in autumn in a cellar, or in a well-drained spot in the open ground.

Grafting the pear. Root grafting is successful with the pear only when large, entire and branching roots are used, and when the grafts are inserted above the crown. Budding the stocks the second year of their growth is more commonly practiced than root grafting. The pear may be top-grafted with considerable facility, but in climates of severe winters the cions should always be cut in autumn.

75. Dwarf pears. The pear is sometimes worked on the French quince. Trees thus grown are much dwarfed, come very early into bearing and thrive on some soils where pear stocks fail. Sometimes the quality of the fruit is improved by grafting the pear in this way. Different varieties of the pear do not grow with equal facility on the quince; a few kinds can be worked upon it successfully only by grafting upon a pear that is already growing upon a quince.

The size of the fruit is generally increased by working on the quince, but it sometimes appears to be rendered more gritty in texture. A few varieties, as the Angouleme, are so much improved when grown on the quince that they are seldom grown otherwise.

In planting dwarf pears, the quince stock is commonly placed a little below the surface to evade the round-headed borer (57), which often attacks the quince, but rarely the pear. The trees are commonly pruned to a conical form, 6 or 7 feet in diameter at the base and 10 or 12 feet in height, the lower branches reaching nearly to the ground. Dwarf pear trees grow less rapidly than those grafted on pear roots. They are therefore less susceptible to blight (62), and may be given more thorough cultivation and more frequent manuring. Dwarf pear trees are also more severely pruned than standards. The new growth is annually cut back to within 4 to 8 buds of the base, and the branches are well thinned out.

76. Distance for planting. Standard pear trees are usually planted 16 to 20 feet apart each way. Dwarf trees may be planted 10 to 12 feet apart.

77. When to pick pears. The stage of maturity suitable for picking pears is commonly indicated by a slight change in color of the skin and by the readiness with which the stem separates from the tree. As a rule, the pear is considered fit to pick when the stem detaches from the tree on lifting the fruit until the blossom end is on a level with the stem. Unlike most other fruits, the quality of the pear is improved by picking before it begins to soften. The finer sorts, however, as the Bartlett and Seckel, suffer less when allowed to ripen on the tree than poorer ones. Summer pears usually color better when ripened in the

dark. Bureau drawers are excellent for this purpose. In the absence of drawers, the pears may be placed on shelves between layers of woolen cloth.

Winter pears should not be picked until damage from frost is feared.

The quality of ripe pears depends considerably upon the environment in which they are grown. A variety possessing the highest quality when grown on a favorable soil, with good culture, may be greatly inferior or worthless grown on uncongenial soil, with improper treatment.

78. Packing the pear for market. Pears are packed for market in baskets, boxes, kegs and barrels, the smaller packages being used for the finer qualities. Many pears are shipped from California to the east in shallow boxes made of thin lumber, in which the pears, individually wrapped in tissue paper, are closely packed, and the box is given no ventilation. When packed in kegs or barrels, the same rules are observed as in packing apples, except that pears should be pressed less hard. Pears are generally "faced" with the calyx end down (66). Pears should always be packed sufficiently immature so that they may arrive at their destination before softening.

79. Insects and diseases affecting the pear. The pear is harassed by numerous parasites, but except those mentioned as common to the pome fruits (49–63), only a few are sufficiently destructive to occasion special anxiety.

80. The pear-tree psylla (*Psylla pyri*) punctures the young twigs near the axils of the leaves in spring, causing a copious exudation of sap that is often so abundant as to drop upon the foliage below, and sometimes to run down the branches to the ground. In severe attacks, almost all of the foliage will be affected, and the tree loses a consider-

able part of its leaves. The insect is so minute as to be scarcely visible without a magnifying glass. Flies and ants gather about in large numbers to sip the sweet sap and are often mistaken for the cause of the mischief.

Preventive measures. Spraying the trees with kerosene emulsion on the first appearance of the trouble generally prevents serious damage.

81. The pear-tree slug (*Selandria cerasi*) is a soft, slimy, blackish or olive-brown, snail-like insect (Fig. 22) that often attacks the foliage of the pear in summer, and sometimes almost defoliates the trees before it is discovered. The insect has two broods, the first of which commonly appears about the middle of June.

FIG. 22.[1]

Preventive measures. As this insect feeds upon the upper surface of the leaves, it is readily destroyed by spraying with kerosene emulsion, or with water containing fresh hellebore powder at the rate of a heaping teaspoonful to three gallons. Trees not bearing fruit may be sprayed with water containing Paris green or London purple. Air-slacked lime dusted over the foliage is also said to be effectual.

The fire blight has been considered in treating the apple (62). The only special precaution to be observed in the case of the pear is to prevent the growth of fruit spurs on the larger branches of the tree. The disease more often affects the fruit spurs of the pear than of other fruits, hence preventing the growth of these on the main branches tends to restrict the disease to the smaller branches, which may be cut off with less damage to the tree.

[1] Pear-tree slug. (After Saunders.)

82. The leaf blight (*Entomosporium maculatum*) is a fungous disease that is often very destructive to young pear seedlings. Its first indication is the dotting of the foliage with reddish-brown spots, followed by the browning and falling of the leaves during summer, which causes premature cessation of growth, and in severe cases totally destroys the seedlings. In older trees the disease may also affect the stems and fruit.

This disease should not be confounded with the fire blight (62).

Preventive measures. The Bordeaux mixture, applied as soon as the first leaves have expanded, and at intervals of 2 to 4 weeks until August 1st, usually prevents this disease. The treatments should be most frequent in damp weather.

C — THE QUINCE

83. The quince is an irregular-growing, shallow-rooted tree or large shrub, attaining a height of 10 or 12 feet at maturity. The fruit, which is firm and acid, and resembles that of the pear in size and shape, is chiefly used for preserves, marmalade, jelly, sauce, and for flavoring sauces made from other fruits. The varieties, which are not numerous, mostly mature their fruit in autumn, and the fruit keeps until cold weather.

While the quince is not an important fruit commercially, quince orchards in favorable locations, when well cared for, have generally proved profitable.

84. Cultural range. The quince is less resistant to cold than the apple or pear, and is about equally subject with the pear to fire blight and leaf blight (62, 82). Its cultural range is therefore narrower than that of the pear. It cannot endure the winters of the northern Mississippi Valley,

and is commercially grown in Canada only in the most favored districts.

85. Propagation. The quince is commonly propagated by layers or cuttings.[1] When propagated as stocks on which to work the pear, mound-layering is usually practiced, but when grown for fruit trees, young shoots are commonly bent down in spring and buried, with the exception of a few buds at the extremity. When these have well started, all are cut away but the best shoot, which is trained upright to a stake. In two or three years the tree may be removed for planting in its permanent place.

The quince is also extensively propagated by cuttings of the young wood, which may be made and planted in autumn. It is also propagated by root cuttings, by budding upon seedlings of the Angers quince, and by root grafting upon apple seedlings. In the latter case the apple root is often removed when the tree is transplanted in the nursery or to the orchard.

86. Fruiting habit. The flowers of the quince are produced on short branches, that grow in spring from small buds terminating spurs borne on wood two years old or older (Fig. 23). The flowers develop to a less extent the season before their expansion than those of most other tree fruits. The trees begin fruiting about 2 years after planting and reach full bearing in 10 or 12 years.

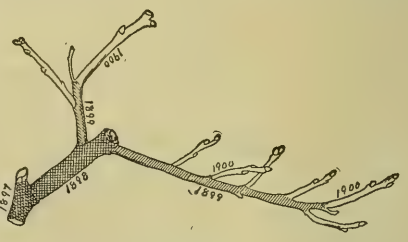


FIG. 23. Fruit spur of quince. (Adapted from Bailey's "Pruning Book.")

[1] Detailed directions for propagating plants from layers and cuttings are given in "Principles of Plant Culture."

87. Soil and culture methods. The quince appears to thrive best on a heavy, retentive clay loam, well-drained. On lighter soils the trees are rarely long-lived. The trees are commonly planted about 15 feet apart each way, three-year-old trees being preferred for planting. The soil of the quince orchard should not be deeply plowed and should always be protected in winter with a cover crop. The vigorous shoots of bearing trees may be profitably cut back more or less each winter or early spring to promote the development of fruit spurs.

88. Insect enemies. The fruit of the quince is injured by a curculio (*Conotrachelus cratægi* — Fig. 24) of which the larva develops within the fruit. The eggs are laid in the young fruit during June, and the beetle may be caught and destroyed in the manner prescribed for the plum curculio (99).

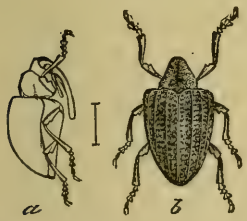


Fig. 24. Quince curculio, back and side view. Much enlarged. (After Saunders.)

The round-headed apple-tree borer (57) attacks the trunk and the pear-tree slug (81) attacks the foliage.

89. Fungous diseases. The fire blight (62) and leaf blight (82) attack the foliage of the quince and are its most serious fungous enemies. A rust (*Rœstelia aurantiaca*) sometimes blotches the fruit and may envelop it in an orange-colored, fringe-like growth. Bordeaux mixture, used as directed for leaf blight, generally prevents this disease.

Section 3.— The Stone or Drupe Fruits.

90. The principal cultivated stone fruits are the plum, cherry, peach, apricot and nectarine. Of these the plum and cherry include several different botanical species. All are small trees or shrubs that exude more or less gum from

wounds, and flower more or less on wood of the previous season's growth. The flower buds are generally lateral, the flowers forming the first year of their life. The fruit is a tender-fleshed, juicy, often highly-flavored drupe,[1] and generally keeps but a short time after maturity. The trees are naturally more fruitful than the pome fruits (41).

91. The soil best adapted to the stone fruits is somewhat lighter, warmer and drier than that which best suits the pome fruits, and it should be abundantly fertile to give best results. Certain species of the plum succeed admirably on a moist, well-drained clay loam.

92. Cultivation. The stone fruits are not subject to the fire blight, and therefore respond more favorably to high cultivation than the pome fruits. Seeding the ground about the trees to grass, or cropping it for the crop's sake, is less admissible than with the pome fruits. Cultivation early in the season, with a cover crop sown about midsummer, should be the rule. In orchards too closely planted to permit cultivation, the ground has sometimes been mulched with excellent results.

93. Picking and packing. The stone fruits do not carry well if allowed to ripen on the tree, but fortunately they acquire most of their quality if picked a little hard. They should not be picked until full grown, and as a rule, not earlier than is necessary to insure that they reach their destination before becoming soft. Plums and cherries should not, as a rule, be picked until fully colored.

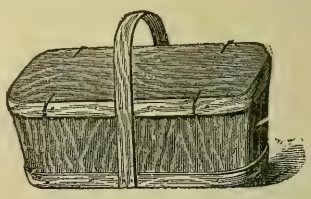


FIG. 25. Climax fruit basket. This is also made with a raised, slatted cover.

[1] A drupe is a fleshy fruit containing a single seed with a bony covering. The seed with its covering is called the pit or "stone."

The stone fruits are commonly packed in the Climax basket (Fig. 25), in the half-bushel market basket, or occasionally in larger baskets. Early and especially choice varieties of the plum and cherry are sometimes marketed in berry boxes.

A—THE PLUM

94. The cultivated plums of the United States and Canada include the following species:

1st. *The European plum* and its American seedlings *(Prunus domestica).* The more common blue and yellow plums of the markets and the dried prunes are of this species. It is the choicest dessert plum. The tree bears large, firm, thick, wrinkled, coarsely-toothed leaves which are mostly downy beneath; the shoots are usually downy, and the flowers are large, as compared with those of other species. The fruit is mostly globular-pointed or oblong, with a large and slightly roughened or pitted stone. This species was introduced into America by the early settlers and is more extensively cultivated than any other. In the northern Mississippi valley its flower buds are not hardy, and its trunk is subject to sun-scald.

2nd. *The Japanese plum* and its American seedlings *(Prunus triflora).* This species was widely disseminated in North America from 1890 to 1900, and the showy, roundish, pointed, firm-fleshed, small-stoned, red, yellow or purple fruit is becoming common in our markets. The flowers are small, clustered, and open earlier than those of most other species. The tree is of rapid growth with usually long, straight, spreading branches, and smooth, obovate, finely-toothed, prominently-pointed leaves. The fruit is generally inferior in quality, but the excellence of a few varieties gives promise of great improvement for the spe-

cies. Its flower buds are not hardier than those of the European plum, and its trunk is more subject to sun-scald. The early opening of its flowers renders it comparatively unfruitful in many localities where its flower buds can endure the winter.

3d. *The northern wild plum* and its cultivated seedlings (*Prunus Americana*) is native along streams and in copses from west New England to Colorado and Texas. The tree is spreading, small and often thorny; the leaves are large, obovate, abruptly pointed, coarsely toothed, conspicuously veined and are never glossy. The fruit is yellow, more or less overlaid with dull red or purple, with a tough and glaucous skin, firm or crisp, sweet flesh and a distinctly margined stone. A division of this species known as the *Nigra group* (Waugh) is distinguished by its large leaves and large, often early-expanding flowers, oblong, oval, often strongly-flattened fruit with a large and much compressed stone.

This species is now considerably grown for fruit in the northern Mississippi valley, where some extensive orchards of it exist. The fruit is becoming popular in the northwestern markets, and is mainly used for culinary purposes. The trees or flower buds are rarely damaged by cold in winter. The pistils are often destroyed by a return of cold weather after a premature warm period in spring, though rarely to an extent to destroy the crop. Improved varieties of this species are rapidly appearing, the finest of which already rival in favor those of the European and Japanese plums. The harshness of the skin and stone, so noticeable in the wild fruit, disappear under good culture.

4th. *The Wild-Goose plum* and allied forms (*Prunus hortulana*) is a strong, spreading, rapid-growing tree with smooth, straight twigs and a peach-like habit, narrow, thin, smooth, usually shining, closely-toothed leaves, and

roundish, bright-red or yellow, juicy, thin-skinned fruit, with a strongly clinging, thick, small, pointed stone. A division known as the *Miner group* (Bailey) is distinguished by duller, thicker, wider, more veiny leaves and by a smoother stone.

This species, which is wild in parts of the Mississippi valley, is regarded by some botanists as a hybrid between *Prunus Americana* and *Prunus Chicasa*. The fruit is less crisp and sweet than that of *Prunus Americana*, which, with its more clinging stone, makes it less desirable for dessert use; the flower buds are also less hardy, which renders the species unproductive in the northern Mississippi valley.

5th. *The Chickasaw plum (Prunus Chicasa* or *P. angustifolia)* is a slender tree, with small, narrow, shining, trough-like leaves, and small, glossy, red or yellow, dotted fruits, with thin skin and soft, juicy flesh closely clinging to the small, broad, roughish stone. It is wild from Delaware, south and west to east Kansas and Texas. The flower buds are often destroyed in winter in the northern Mississippi valley.

The fruit of this species is decidedly smaller and less highly flavored than that of *Prunus Americana*, and is suitable only for culinary uses, for which it is especially desirable.

The trees of the different species of plum are hardy throughout the United States and Southern Canada, when their trunks are prevented from sun-scald.

Hybrid plums. A number of hybrids have been artificially produced between certain of the above species, especially between the Japanese plum and others. The European plum apparently resists hybridization more than the other species. As the hybrids increase in number, it will doubt-

less become more and more difficult to refer the varieties to their proper species.

95. Fruiting habit. The plums fruit mostly on spurs, but as the flower buds are mainly lateral, the spurs do not branch as in the pome fruits, but continue to grow from their terminal bud, unless this also flowers or dies from lack of light, when the spur perishes, becoming a thorn-like branch. On the young shoots, a flower bud often forms on either side of the buds in the axil of a leaf, but flowers from these do not often form fruits. The spur-buds commonly flower at the beginning of their second year (Fig. 26).

The trees usually commence bearing at two to three years after planting in the orchard.

96. Pruning. The plum requires little pruning except such as is needed for symmetry and to maintain a free, open, head. The trees of some varieties incline to split down, hence the new growth should be kept well cut back, and forks in the stem should be carefully avoided. Many varieties of *Prunus Americana* tend to produce very dense heads, which should be thinned out by removing the smaller branches. This tends to prevent overbearing, and to increase the size of the fruit.

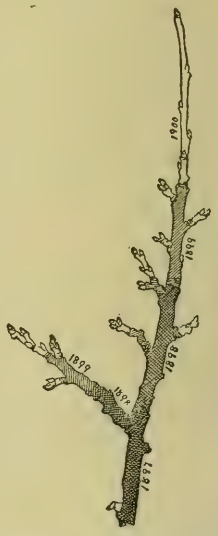


Fig. 26. Fruiting branch of European plum. (Adapted from Bailey's Pruning Book.)

97. Picking plums. Plums of the European class should be picked with the stems, but the stems of most native varieties detach as the fruit ripens. Plums should be handled as little as pos-

sible to avoid removing the delicate bloom that gives an appearance of freshness.

Plums do not often ripen uniformly enough to permit all to be picked from the tree at one picking, and the fruit generally becomes too ripe for marketing if allowed to drop. It is usually necessary to pick over the trees two or more times, the color of the fruit indicating which ones are to be picked.

98. Parasitic enemies. The chief parasitic enemies of the plum are the plum curculio, plum gouger and aphidae (53) among insects, and the "fruit rot," black knot, and "plum pockets" or "bladder plums" among fungi. These are treated in order.

99. The plum curculio (*Conotrachelus nenuphar*) (Fig. 27 c.) is the chief insect enemy of the plum and cherry. It is native to America and formerly bred in the wild plums. On the introduction of the European plum, it attacked this fruit so vigorously, until preventive measures were discovered, as to threaten its extermination from culture.

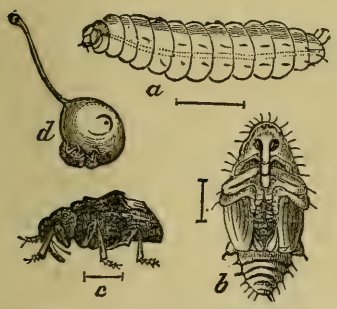


FIG. 27. Showing plum curculio, and stung fruit; *a*, larva; *b*, chrysalis; *c*, beetle; *d*, stung plum, showing crescent-shaped mark. Natural size indicated by short lines. (After Saunders.)

The perfect insect is a rough, grayish or blackish beetle, about one-fifth of an inch long. The females begin to lay their eggs in the green fruit soon after the petals fall. The length of the egg-laying period is from two to five weeks, and depends much upon the weather, it being prolonged in cold and wet springs.

In the plum and some other fruits, the female exposes her work by a crescent-shaped mark (d) about the point of egg deposit. On the hatching of the egg, the larva feeds upon the pulp of the fruit until it attains its growth, when it leaves the fruit and descends into the ground 4 to 6 inches for transformation. More or less gum generally exudes from the wounds made in the egg-laying, and in the plum, the fruit usually drops before maturity; but in cold and backward springs the egg-laying may be so far retarded that the larvæ are found in the ripe fruit. The plum curculio is single brooded, and the beetle passes the winter under the loose bark of trees or in similar places.

Preventive measures. Early in the season the beetle feeds somewhat on the foliage, and hence may be destroyed to a slight extent by spraying the tree with water containing an arsenite, but the number of beetles that may be thus destroyed is not always sufficient to repay spraying for this purpose alone. The so called "jarring process" is more effectual. In this, advantage is taken of the stiffness in the beetles caused by cold, to jar them from the tree upon sheet-covered frames, where they may be killed. The trees are gone over, usually in the early morning, with the curculio catcher (Fig. 28), which is run beneath the tree so that the trunk is near the center of the sheet. A stub, formed by sawing off a small branch of the tree, is then struck two or three vigorous blows with a cushion-covered mallet, when the curculios, with other insects, drop on the sheet, whence they are swept into

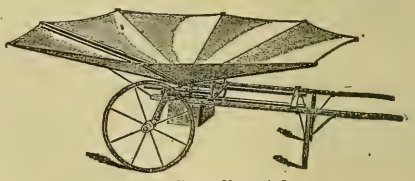


Fig. 28. Curculio catcher.

a box beneath the center of the sheet to be later destroyed by kerosene. In case of the plum, all fruits that fall as the result of infection by larvæ should also be promptly gathered and destroyed by burning or otherwise.

100. The plum gouger (*Coccotorus scutellaris*) is sometimes as destructive to the native plums as the curculio, for which it is often mistaken. It is much larger than the latter and appears in spring at about the same time. Unlike the curculio, the female does not mark her place of egg deposit with a crescent-shaped mark, and the larva feeds on the kernel of the pit. Fortunately the plum gouger is destroyed by the treatment recommended for the plum curculio (99).

The flat-headed apple-tree borer (58) often injures the trunk of the plum when the bark has been damaged by sun-scald or otherwise.

101. The fruit rot. Certain varieties of nearly all of the stone fruits are subject to disastrous rotting on the trees at the time of maturity, especially if the weather at this season is warm and wet. The rotting is the direct result of a fungous disease and may be in part prevented. The fungus (*Monilia fructigena*) attacks the flowers, leaves, and fruit spurs, as well as the fruits. It makes its appearance on the flowers about the time the petals fall, and may proceed from the flower to its stem, destroying that also. The dead flowers usually remain on the tree 3 or 4 weeks, when, if the weather is wet, they are distributed to other parts of the tree, to which they spread the disease. If the weather at the time of fruit maturity should be warm and rainy, the fungus in the fruit may progress with astonishing rapidity, causing total destruction of a large crop. The decayed fruits, if undisturbed, may remain on the tree until the following spring.

Preventive measures. The disease gains entrance to the flowers through spores that live from year to year. Since every fruit destroyed by the fungus matures millions of spores, every decayed fruit that is permitted to hang on the tree until the following spring is a source of infection to the next crop. As soon as the ripe fruits that escape the rot have been gathered, all decayed ones, whether on the tree or on the ground, should be collected and destroyed by burning or burying. It is wise, also, to rake up and burn the fallen leaves in autumn, and thus destroy all adherent spores of the fungus. Spraying the trees with Bordeaux mixture in early spring, taking care to thoroughly wet the trunk and branches will tend to prevent the germination of spores on the tree, and thus lessen the chances of infection of the flowers. Spraying the fruit at the approach of the ripening period with a solution of potassium sulfide, at the rate of one-half ounce to a gallon of water, also tends to prevent the disease. Early picking of the fruit, provided it is picked quite dry, usually prevents serious damage from rotting.

Planting and pruning the trees with reference to securing abundant circulation of air among the leaves and fruit, and thinning the fruits so that no two specimens hang in contact, also tends to reduce the rot.

102. The black knot of the plum and cherry (*Plowrightia* [*Sphœria*] *morbosa*) is a fungous disease that attacks the younger branches, causing abnormal, dark-colored swellings of the wood, and sooner or later destroying the affected parts.

Preventive measures. Spraying with Bordeaux mixture has been found to reduce the number of affected branches, but where the disease has secured a foothold, the branches should be promptly cut off and burned.

103. Plum pockets or bladder plums. The plums native to America are often attacked by a fungus (*Exoascus* [*Taphrina*] *Pruni*), that causes the young fruits to swell up in a conspicuous and abnormal manner, assuming at first a gray color which later changes to brown or black. Affected fruits are destroyed and finally fall. The disease also affects the leaves and young stems, causing similar distortions. It does not, however, appear to spread much from tree to tree, and is mostly confined to a few varieties.

Preventive measures. Watch should be kept for the appearance of the disease in spring and early summer, and all affected fruits and leaves should be destroyed. Spraying trees inclined to the disease with Bordeaux mixture as soon as the foliage appears in spring will doubtless tend to prevent the attack. Varieties found specially susceptible to the disease should be discarded.

The foliage of the plum is also sometimes injured by the shot-hole fungus (130).

104. Propagation of the plum. Various stocks are used in propagating the plum. In localities where the Domestica species succeeds, the Myrobolan stock (*Prunus myrobolana*) is much used and is generally satisfactory except on light or otherwise unfavorable soils.

Seedlings of *Prunus angustifolia* are much used in the southern states, but have the objection of suckering from the roots. The Marianna plum, which is supposed to be of the Myrobolan class, and which grows readily from cuttings in the south, is also used to some extent. The most satisfactory stock for the plum, at least in the northern states, is undoubtedly seedlings of the Americana plum. The peach was at one time considerably used as a stock for the plum, but has now been nearly abandoned.

Growing seedlings. Pits for producing stocks should be gathered from vigorous, healthy plum trees. They should be removed from the pulp and stratified in sand, or the fruits may be mashed in plenty of sand, and the sand containing the pits should be buried a few inches deep in the soil, in a well-drained place, until early the following spring, when the pits should be planted not over three-fourths inch deep, 3 or 4 inches apart, in rows 3½ or 4 feet apart.

To prevent washing-out of the pits, the planted rows may be covered with narrow boards until the young plants appear, when the boards should be promptly removed. After the plants have started, the soil about them and between the rows should be well cultivated throughout the season.

Grafting. The young trees should be large enough for budding by the latter part of summer. If the seedlings are intended for crown-grafting, cions may be cut the following spring, after frost has left the ground, but before growth has started in the stocks or cions, and inserted at once in the crown of the seedling. Root-grafting the plum is not generally satisfactory. The trees may be top-grafted with fair success, as described for crown-grafting, or with autumn-cut cions, tightly packed in dry leaves and kept over winter in a cool cellar.

Propagation from root cuttings. The plum is readily propagated from root cuttings taken from trees that are growing "on their own roots," *i. e.*, that have not been grafted. The shallow roots may be cut into three-inch pieces in autumn and packed in boxes with alternate layers of moist sand, and the boxes may be stored over winter in a cool cellar. As early in spring as the soil can be worked, the cuttings are planted upright, with their distal end about three-fourths of an inch below the surface.

105. Soil and planting. The best soil for the plum is a moderately-heavy clay loam, though some varieties succeed admirably on rather light soils. A suitable distance for planting the trees is 20 to 25 feet apart, depending somewhat upon the vigor of the variety.

The varieties of the American species of the plum are largely impotent with their own pollen — a fact that greatly emphasizes the importance of mingling the varieties in planting (14).

B—THE CHERRY

106. The cultivated cherries of the United States and Canada include the following species:

(a) *Prunus avium*, the bird cherry of Europe, the sweet cherry of North America, or the English cherry, to which the classes known as Mazzards, Hearts, Bigarreaus and Dukes belong, is characterized by the usually tall, upright growth and pyramidal form of the tree. This has large, vigorous and straight young branches, with soft, coarsely- or doubly-toothed, pointed leaves, which are usually pubescent beneath. The flowers are developed at the same time with the leaves, and the usually sweet or bitter fruit is round-ovoid or somewhat heart-shaped and of various colors. The cultural range of this species is rather limited and it is not hardy in northern United States nor in Canada except in favored districts. The fruit is used for dessert, canning and pickling.

(b) *Prunus cerasus*, the red, sour, or pie cherry, which is a smaller tree than the above and includes the Amarelle and Morello classes, has small, irregular and thickly-growing branches, with obovate lance-ovate, serrate leaves, rather large flowers on shortish pedicels that somewhat

precede the leaves, and a decidedly acid, roundish, commonly red fruit. This species is hardier than the last, and is grown with some success in the colder parts of the United States. Its flower buds are, however, often destroyed in winter in the northern Mississippi Valley. The fruit is chiefly used for pies and canning.

(c) *Prunus Besseyii*, the dwarf or sand cherry, is a low straggling shrub which has recently been cultivated in an amateur way. Its fruit more resembles that of the sweet than the sour cherry, and its variability suggests that it may be susceptible to improvement.

107. Fruiting habit. The fruit of the cherry is mostly borne from lateral buds on short spurs from wood of the preceding year (Fig. 29), *i. e.*, the buds that form in the leaf axils of the young shoots grow out into short branches (spurs) the next year, the lateral buds on these spurs forming flowers that expand the following spring. These spurs may persist two or more years by growth from their terminal buds, which seldom flower, but they commonly perish in a year or two through lack of light. Sometimes the lower buds on the young shoots form flowers the first season.

108. Soil for the cherry. The cherry thrives best on a dry, sandy or gravelly loam. It is especially subject to damage from over-wet and poorly-drained soils.

FIG. 29.[1]

[1] Fruiting wood of sour cherry. F, flower buds; L, leaf buds.

109. Propagation. Seedings of the bird cherry are much used for stocks, both for its own species and for the varieties of *Prunus cerasus.*

The mahaleb cherry (*Prunus mahaleb*) is also used to produce a somewhat dwarfed cherry, and possesses the advantage of thriving on heavy clay ground. Neither of these stocks is entirely successful in the northern Mississippi valley, but the mahaleb appears to be the hardier of the two.

The seeds may be treated as directed for the plum (104), but must be planted very shallow, and unless the soil is rather light, they should be covered with leaf mold, fine sand or thoroughly decayed manure, to avoid the formation of a crust over them. The seedlings are not often large enough to bud until the second season. They should commonly be taken up the fall after sowing and buried in well-drained soil, or stored in a cool, moist cellar until the following spring. Budding the cherry is practicable only with thrifty stocks and well-matured buds. The most favorable time for budding is just as the terminal buds on the shoots commence to form. It is said to be important to cut out with the bud a section of wood reaching about one-third through the shoot.

Grafting the cherry otherwise than by budding is rarely successful unless performed very early in the spring, before frost has left the ground.

110. Pruning. The cherry requires only sufficient pruning to form a symmetrical head and to admit sunlight to the fruit spurs. In countries of severe winters it is important to head the trees low and to protect the trunk against sun-scald.

111. Picking and marketing. The mature fruit of the cherry is much subject to destruction by birds. To prevent this, it is often necessary to gather the fruit before it

softens. The trees of choice varieties are sometimes protected against birds by inclosing them with cotton netting.

The cherry is commonly marketed in the Climax basket (Fig. 25), in half-bushel market baskets, or in berry boxes (212). Choice varieties are often shipped from the Pacific states, closely packed in unventilated boxes, in layers separated by tissue paper.

Insects and diseases. The plum curculio (99) and the pear-tree slug (81) are the most serious insect enemies of the cherry. The fruit-rot fungus (101) is often destructive. A species of *Exoascus* (103) often affects the sand cherry.

C—THE PEACH

112. The peach (*Prunus persica*) is one of the most delicious tree fruits of temperate climates.

The trees are more tender and of shorter duration than those of most other temperate fruits. Peach orchards often decline after bearing 2 or 3 good crops, but under more favorable conditions they continue 20 to 25 years. Lack of proper culture has undoubtedly ruined many American peach orchards.

The cultivated peaches are commonly referred to a single species, but at least two botanical varieties are recognized, viz., var. *lævis* or *necturiana*, the nectarine, of which the fruit is smooth and usually smaller than that of the common peach and var. *platycarpa*, the flat or Peen-to peach, of which the fruit is much flattened endwise. The nectarine is not grown commercially in North America except to a limited extent in the Pacific states. The Peen-to peach is grown to some extent in Florida and on the Gulf coast.

113. Cultural range. The most extensive commercial peach-growing regions of the United States are in New

Jersey, Delaware, Maryland, Georgia, Michigan, Connecticut, New York, Colorado and the Pacific States. The crop is quite uncertain throughout most of the Mississippi Valley and Gulf States owing to the sensitiveness of the flower buds to warm weather in winter, which causes them to swell at the least provocation. Under ordinary circumstances the dormant flower buds are destroyed by a temperature of 12 to 15 degrees below zero, F., though they have sometimes endured a considerably lower temperature. When slightly swelled by untimely warm weather, they are often cut off at a temperature of only 5 or 6 degrees below zero.

A careful study of local conditions might extend the culture of the peach to many new sections of small extent. It is grown commercially to some extent in the most favored regions of Canada.

114. Fruiting habit. The flower buds of the peach are formed rather late in the growing season, on either side of the buds, in the axils of the leaves on the young shoots. Rarely, the axillary bud also flowers. The flowers are single and open before the leaves expand. The trees often begin fruiting at three years of age.

115. Propagation. The peach is more precocious than most other tree fruits. Stocks may be budded the same season the pits are planted, and in the southern states, the young trees may be planted in the orchard the following spring. In the north, trees grown one year in the nursery after budding are preferred.

The peach is commonly budded upon its own seedlings. For stocks, only the seeds of hardy and late varieties, from orchards not subject to yellows (121), should be used. The pits may be kept in a cellar without stratification until winter, when they should be stratified and exposed to freez-

ing and thawing. About the time the frost leaves the ground, they are often taken up and cracked by hand, placing them on the end of a wooden block and striking each a gentle blow on the edge with a hammer. The kernels are then taken out of the shells and planted at once, 1 or 2 inches deep, and 6 or 8 inches apart, in rows sufficiently separated to admit of horse cultivation. To secure a good stand of plants, the kernels are often sprouted before planting by mixing them with moist sand and leaf mold and spreading thinly where exposed to the sun's rays, the sprouted pits being planted with a trowel. If the ground cannot be prepared early, germination may be retarded by burying the uncracked stones a foot or two deep, until wanted.

Vacancies in the rows may be filled from a seed bed when the plants are very young. If the weather is dry, the ground should be watered.

The pits may be planted without cracking by mixing the fresh stones with moist sand and spreading the mixture in a layer not over 6 inches thick on the ground, covering this with a few inches of partially rotted straw or coarse manure to prevent drying. This covering should be removed at the beginning of winter to favor freezing of the pits. In spring, a large portion of the pits will be found sprouting. The sprouted pits are then carefully picked out and planted at once as above directed. In a few days another portion will be found sprouted which may be picked out and planted as before, and this assorting and planting process should continue as long as the pits continue to sprout. Those which do not sprout the first spring may be covered again with coarse manure and exposed to freezing the second winter.

If the soil is fertile and kept well cultivated, the trees will usually be large enough in the northern states to bud by the close of summer. In the south, they may be budded in June.

The peach is sometimes worked upon plum stocks, though the practice is not now regarded with much favor. The plum stock slightly enfeebles the growth and also lessens damage from the peach borer (121). Dwarf peach trees are produced by budding on the Mirabelle, a diminutive variety of the plum.

116. Soil. The peach is very often grown on sandy soil, and with a favorable climate, trees thus grown succeed and fruit well for a time; but they do not, as a rule, endure so long as when grown on fertile and well-drained clay loams.

117. Orchard planting. The peach may be successfully transplanted to the orchard the spring after the insertion of the bud, but trees two years old from the bud, are as a rule, more satisfactory than younger ones. The trees may be planted 15 to 20 feet apart. The branches are commonly cut back to within one bud of the trunk, and the top is considerably shortened (Fig. 30).

Fig. 30.[1]

118. Pruning. Since the peach bears on wood of the preceding season's growth, that pruning should be practiced which tends to develop abundance of new wood near the trunk. Neglected trees usually develop long, slender branches with little new wood, which is produced at the extremities, and the fruit on these tends constantly to split down the branches. In many orchards the new growth is annually cut back from one-half to one-third its length in early spring, and the center of the

[1] Young peach tree pruned, ready for planting in orchard. (From Bailey's "Pruning Book.")

tree is kept open by cutting back 2 or 3 season's growth if need be (Figs. 31 and 32). The cutting back of the annual growth is less essential when the peach is grown on light than on heavy soils.

FIG. 31. Young orchard peach tree before pruning. (From Bailey's "Pruning Book.")

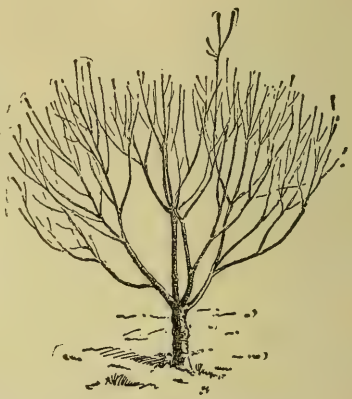


FIG. 32. The same tree as Fig. 31, after pruning.

119. Picking and packing. Peaches should not be picked, as a rule, until they are full-grown and have begun to assume their mature color, as they do not often color perfectly after picking. "It is very difficult to describe that period of maturity when a peach is ready for picking. An experienced picker will take the fruit softly in his hands and press the ball of his thumb very lightly upon the side, and if the fruit has a somewhat springy feeling, it is ready to take off the tree." [1]

Peaches are often marketed in round-topped baskets with

[1] Principles of Fruit Growing, Bailey, 382.

a hexagonal base (Fig. 33). To enable the picker to use both hands, one of these baskets may be slipped into a ring strapped about the waist. The basket, when filled, is replaced by an empty one to avoid pouring the fruit from one basket to another.

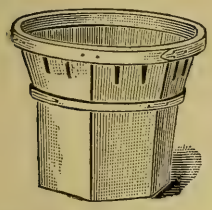


FIG. 33. Peach basket.

120. Insects and diseases. The most harmful insects are the plum curculio (99) and the peach-tree borer. Among diseases, the yellows, rosette, leaf curl, "little peach" and fruit-rot (101) are most serious.

121. The peach-tree borer (*Aegeria excitiosa*). The female of this insect lays her eggs on the bark near the surface of the ground, from the latter part of May until the end of August, the time depending much upon the locality. The larva penetrates the bark and sap wood of the root, causing a copious exudation of gum about the base of the tree, which reveals the presence of the insect.

Preventive measures. The larvæ may be cut out with a knife late in the autumn or early in spring by removing sufficient earth about the base of the tree. After this the tree may be banked up with earth to the height of a foot or more late in the spring, or toward mid-summer in the northern states. The mound should be leveled off in September, after egg laying has ceased. Protecting the trunk with straw, tied upright about it and extending a few inches below the surface of the soil, has also been recommended.

122. The yellows is the most dreaded disease of the peach. It has destroyed many peach orchards and almost annihilated peach culture in some localities. Its infallible indications are premature ripening of the fruit, accompanied by small, bright-red spots upon the skin, and pur-

ple discoloration, with insipid flavor of the flesh. The following season, numerous slender shoots often appear on the larger branches, accompanied by yellowish and sickly foliage over the whole tree. Death of the tree soon follows. The cause of, and remedy for this disease are unknown.

Preventive measures. Root out and burn all affected trees as soon as discovered, and use no pits or buds from infested districts for propagation. In some states, laws requiring the immediate destruction of infested trees have been rigidly enforced, with the result that the disease has been nearly exterminated.

123. The leaf curl, due to the fungus *Exoascus deformans*, is an abnormal development of the foliage in spring or early summer, in which the leaves assume a more or less puckered form and whitish color. In severe attacks the trees become nearly defoliated and the fruit crop is destroyed. The disease is most common and most serious in wet seasons and in humid climates (103).

Preventive measures. Recent experiments have shown that spraying peach trees with Bordeaux mixture composed of 5 pounds of copper sulfate, 5 pounds of lime and 45 gallons of water, shortly before the opening of the flower buds, has largely prevented damage from leaf curl.

124. The rosette is a serious disease of peach trees in Southern United States. It is characterized by dense clusters of foliage on the young shoots and soon proves fatal. Its cause is a mystery and the only preventive measure known is the same as described for the yellows (121).

125. "Little peach" is a disease that has recently appeared in parts of Michigan and New York. The peaches fail to enlarge or ripen; the trees lose vigor and finally die. The

cause of this disease is also unknown, and the only preventive measure is the one described for the yellows (121).

D — THE APRICOT

126. The apricot (*Prunus Armeniaca*) resembles to a certain extent both the peach and plum. The fruit, which ripens earlier than either the peach or plum, resembles the peach, but is smoother, has rich, yellow flesh and a large, flat, smooth stone. The leaves are roundish and pointed; the tree resembles the peach tree in size and form.

Fig. 34.[1]

The apricot is used for dessert, for canning and for drying. It is extensively evaporated in parts of California.

127. Cultural range. The apricot can be grown in about the same localities as the peach, but requires a somewhat stronger soil and more careful treatment, as it is more subject to damage from frost and insects. It is grown commercially to some extent in the Eastern and middle states, but chiefly in California.

128. Fruiting habit. The apricot bears its flowers on either side of the leaf buds on young shoots, like the peach, and also on short spurs from the preceding year's growth, like the plum (Fig. 34). The flowers expand very early in spring and hence are especially liable to be injured by frost. The trees commence bearing at 3 or 4 years old, and under the best conditions, are nearly or quite as productive as the peach tree.

[1] Fruiting wood of apricot. S S, spurs.

129. Propagation. The apricot is commonly budded upon seedlings of the peach (115) both in the east and west. Plum stocks are sometimes used for adapting it to soils where peach stocks do not thrive.

130. Insects and diseases. The plum curculio (99) is the most serious insect enemy of the apricot. In California the tree is troubled by various scale insects (142). The foliage is sometimes injured by the shot-hole fungus (*Cylindrosporium padi*), for which Bordeaux mixture is a preventive.

SUMMARY OF THE PEAR, QUINCE AND STONE FRUITS.

1. The cultural range of the pear is much restricted owing to its susceptibility to fire blight (70).

2. A well-drained clay soil of moderate fertility, and a cool, airy location suit the pear best (71).

3. The tillage and fertilization of the standard-pear orchard should be less thorough than that recommended for the apple (73). The dwarf-pear orchard may be more liberally tilled, manured and pruned than the standard-pear orchard (75).

4. The standard pear is commonly grafted upon pear seedlings; the dwarf pear upon the French quince. Pear seedlings are liable to be destroyed by leaf blight, and by being heaved out by frost. A few varieties of the pear are more successful when worked upon the quince than upon pear seedlings (74, 75).

5. The quality of most pears is improved by picking the fruit before it begins to soften, and storing in darkness (77).

6. To confine the fire blight to the younger branches of the pear tree, it is wise to remove fruit spurs from the trunk and older branches (81). The leaf blight may be controlled by spraying with Bordeaux mixture (82).

7. The cultural range of the quince is narrower than that of the apple, and the fruit is used almost wholly for culinary purposes. Quince orchards, properly located and cared for, have generally proved profitable (83, 84).

8. The stone fruits succeed on lighter and drier soil than that best suited to the pome fruits. The trees may, therefore, be more liberally cultivated and manured. The flower buds form flowers the first season of their life, hence the fruit is borne on wood of the preceding year (90, 91, 92).

9. Five different botanical species of the plum are cultivated in the United States and Canada. Of these, only the northern native plum is hardy in the more northern sections. The European plum is most generally grown (94).

10. The plum fruits mainly on spurs from two or three-year-old wood. The tree requires little pruning, as a rule (95, 96).

11. The chief insect enemy of the plum and cherry is the plum curculio. It is mainly held in check by the "jarring process" (99).

12. The fruit rot, a fungous disease that attacks the fruit as it approaches maturity, is often a cause of serious loss to the plum and cherry grower in wet seasons. Spraying the fruit just before the picking season, liberal thinning of the fruit, and picking it when a little hard, are the most important preventive measures (101).

13. The most satisfactory stock for the plum, at least in the north, is seedlings of *Prunus Americana* (104).

14. Two botanical species of the cherry are extensively cultivated in the United States and Canada. Of these, the sour cherry (*Prunus cerasus*) has the much wider cultural range (106). The fruiting habit of the cherry closely resembles that of the plum (107).

15. The cherry thrives best on a warm, dry, sandy or gravelly loam (108).

16. Seedlings of the bird and mahaleb cherries are chiefly used as stocks for the sweet and sour cherries. The mahaleb is the more resistant to cold of the two (109).

17. The peach tree is less resistant to cold than the plum or cherry, and its flower buds are more readily excited by warm weather in winter. Its cultural range is therefore comparatively narrow (112, 113).

18. The peach fruits on wood of the preceding season, and not from spurs (114). It is propagated by budding on peach seedlings (115).

19. Peach orchards are commonly most enduring on fertile, well-drained, clay loams (116).

20. The peach tree should be pruned to develop an abundance of new wood near the trunk (118).

21. Peaches should be picked when they are full-grown and have begun to assume their mature color (119).

22. The peach is much subject to disease. The yellows, rosette and "little peach" are three serious diseases for which no remedies are known. The only preventive measure practiced is destruction of the affected trees. The leaf curl is held in check by spraying with Bordeaux mixture (122–125).

23. The apricot resembles the peach in most characters that have a bearing on culture. Its cultural range is narrower than that of the peach (126–127).

SUGGESTIONS FOR LABORATORY WORK.

1. Study the insects and diseases affecting the pear, quince and stone fruits, from the trees and fruits, so far as practicable, and apply the preventive measures recommended.

2. Practice grafting the above-named fruits, so far as means and the time of year permit.

3. Study the trees of the above-named fruits until each species can be recognized at a glance. This study may be made at any time of the year.

4. Practice picking and packing the fruits of the different species, so far as the season permits.

5. Practice naming standard varieties of fruit from the descriptions in Downing's "Fruits and Fruit Trees of America."

6. Practice writing descriptions of mature samples of standard varieties of fruits.

7. Begin a collection of pits of the different varieties of the stone fruits, to be used later for determining varieties. Number each pit, and catalogue the varieties by number.

Section 4.—The Citrous Fruits

131. The principal citrous fruits grown commercially in the United States for their fruit are the following:

(a) The sweet orange (*Citrus aurantium*, variety *Sinensis*).

(b) The mandarin or kid-glove orange (*Citrus nobilis*).

(c) The lemon (*Citrus medica*, var. *Limon*).

(d) The lime (*Citrus medica*, var. *acida*).

(e) The pomelo (*Citrus Decumana*).

All are small trees or shrubs with evergreen leaves, and are hardy only in the extreme south or southwest. The fruit of all the above species is injured, while on the tree, by a temperature slightly below the freezing point, and the younger branches of the trees are destroyed by moderate freezing.

A—THE ORANGE

132. The sweet orange is a tree 25 to 30 feet high at maturity. The fruit is prized for dessert and marmalade in all countries, and the tree is extensively cultivated in warm climates.

133. The mandarin or kid-glove orange is a shrub or small tree, of which the fruit is smaller and more compressed than that of the sweet orange. The skin is readily removed with the fingers, even with gloves on, hence the name "kid-glove" orange. Its flavor is unlike that of the sweet orange, but is relished by many. The mandarin is extensively cultivated in orange regions that are free from hot winds, but the fruit is less common in the northern markets than the sweet orange.

134. Cultural range. The orange is grown commercially in central and southern Florida, the delta region of the Mississippi river and in California. It is likely to be grown in the future in parts of Texas, New Mexico and Arizona.

In central Florida, and on the Mississippi delta, the orange orchards have suffered much from freezes in winter. Though the trees are not often destroyed by this cause, their fruitage is rendered uncertain. The early ripening of the fruit in these sections, and the fact that irrigation is unnecessary, renders orange growing very profitable when the orchards escape damage by frost.

135. Fruiting habit. The orange, in common with other citrous fruits, blossoms at the end of short branches from the preceding season's growth. After a branch has fruited, another grows out below and overreaches it, to bear fruit in the future. The trees begin to bear at about 3 years of age, and increase in productiveness for several years.

136. Propagation. The orange may be propagated from seeds, cuttings or layers, but seeds are chiefly used. In California the seeds are largely saved from commercial Tahiti oranges; in Florida, any oranges not too valuable are used. The seed should not become dry before planting, though that of *Citrus trifoliata* will endure slight drying. It should be planted about an inch deep in light, rich soil, and should be mulched or frequently watered in dry weather. The seedlings appear in from 2 to 6 weeks. They should be shaded somewhat to protect them from heat, and should be sprayed with Bordeaux mixture to prevent dampimg off. In Florida the seedlings may be planted in nursery rows during the summer rainy season, but less loss occurs when one-year-old plants are transplanted in midwinter. The seedlings should be watered when transplanted, and afterward if needed.

In California young trees in the nursery are often protected from frost by being covered with a framework overlaid with cypress brush.

Stocks. *Citrus trifoliata* is chiefly used for stocks where the orange tree frequently suffers from cold; in other sections the sour or bitter orange (*Citrus aurantium*, var. *amara*), or the "rough lemon," supposed to be of hybrid origin, is chiefly used. Seedlings of the sweet orange are subject to a disease known as "foot rot."

Budding. In California, seedlings are budded either in spring or autumn, after they have grown a year in the nursery. In Florida they are more often allowed to grow 3 or 4 years in the nursery before budding, and are mostly budded just before growth ceases in fall. In cutting back the stock after budding, a stub is commonly left for a time, above the inserted bud, to which the shoot from the latter is tied. Grafting other than budding is seldom practiced.

Old trees are top-worked by being cut back severely and budded in the vigorous shoots that grow from the remaining branches.

137. Soil. The orange succeeds best on deep, rich, well-drained soil. In parts of Florida it is grown extensively on sandy land, with abundant fertilizing. In the delta of the Mississippi, it is grown on deep alluvial soil. In California, alluvial soil formed of granite and limestone is considered best; hard-pan subsoil and strata of sand and gravel are considered objectionable. The orange requires abundant fertilizing to maintain productiveness. In Florida commercial fertilizers are extensively used.

138. Planting in the orchard. In California, orange trees are planted in the orchard at 3 or 4 years old from the seed; in Florida, at 4 or 5 years old from the seed. Standard trees are planted at 24 to 40 feet apart, though trifoliata stocks (136) may be set closer. In Florida, if orchards are to be planted on new land, the holes for the trees are dug 2 or 3 months before planting, and the soil thrown out is "sweetened" by mixing lime with it.

Care should be taken to prevent the roots from drying in transplanting; the tops should be well cut back, and the leaves are often removed to prevent loss of water by transpiration. Abundance of water should be used in planting. In California, protection of the trunk after planting is considered important.

139. Orchard culture. The soil of the orange orchard is generally kept cultivated, but in Florida, cultivation is abandoned after the summer rains begin and a fertilizing cover crop is planted, or crab grass is permitted to cover the ground; the orchard is mown before the fruit harvest. Three applications of a fertilizer rich in potash are often made in Florida during the season, the first in De-

cember, the second in May or June, and the third just before the fruit matures.

140. Harvesting and packing. The fruits are commonly cut from the tree to avoid bruising. They are exposed to the air two or three days for "wilting," after which they are wrapped individually in tissue paper and packed in boxes with moderate pressure.

In Florida, and the delta region, harvesting of the early varieties may begin in October, but in California the crop is about a month later. The later varieties mature several weeks after the earlier ones. All varieties may be left on the trees for several weeks after maturity without damage.

141. Protecting trees from cold. In northern Florida and the delta region the trunks of orange trees are usually banked from 1 to 4 feet high on the approach of freezes, which are announced by the Weather Bureau some time before their arrival. This saves the budded stem, but the branches are often destroyed. Shoots will, however, grow out rapidly from the protected part of the stem and the trees will soon recover. Sheds of slats or canvas are sometimes built over the trees in north Florida, and in severe weather the air within these is heated by fire, or kept from frost by spraying with water.

142. Harmful parasites. The orange is comparatively little injured by parasites or disease, with the exception of scale insects, of which several species are injurious. For these, various oils or caustic washes are used with more or less success.[1]

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[1] Formulae for two of these washes are given in "Principles of Plant Culture." For several others, consult Wickson's "California Fruits." (Dewey & Co., San Francisco.)

B — THE LEMON

143. The lemon is a bush or small tree with smooth, yellowish-green shoots. It is less resistant to cold than the orange, and its fruiting branches are longer and more spreading.

Cultural range. The lemon thrives best in a nearly frostless climate, but requires somewhat less summer heat than the sweet orange — conditions that are found in the United States only in southern Florida, and in the coast region and some interior valleys of southern California.

144. Culture of the lemon. The trees are mostly budded on seedlings of the sour orange or "rough lemon" (136). They succeed best on a lighter and warmer soil than is suited to the orange. The trees are planted 20 to 25 feet apart, and the planting and orchard culture are as described for the orange (138, 139). In Florida the orchard is fertilized, at the rate of 800 to 1,500 pounds per acre, with a mixture of sulfate of potash, sulfate of ammonia and bone black. The trees are pruned by shortening the slender fruiting branches and thinning out the superfluous shoots.

145. Harvesting and curing. The fruits are commonly cut from the tree as fast as they attain a diameter of $2\frac{1}{4}$ inches, as measured with an iron ring, usually before they begin to change color. They are handled in shallow boxes, which are piled, with air spaces between, in curing houses arranged to give good ventilation without exposing the fruit to drafts of air or great changes of temperature. The crop is mostly picked in winter, but is not marketed until the next summer. The fruits are packed for market as directed for the orange (140).

C — THE LIME

146. The lime is a low, much-branched, very thorny tree or shrub that thrives on poorer soil and nearer salt water than other citrous fruits. The fruit is prized in tropical countries for cool drinks and in cookery, and is much used for making citric acid. Most varieties of the lime are more tender to endure cold than the lemon, but a single sort — the Sour Rangpur, from India, is as hardy as the sweet orange. The variety most grown in Florida is the West Indian, which is grown from seed. Other varieties are budded on the "rough lemon" and sour orange (136). The trees are planted 15 to 25 feet apart and cultivated like orange trees (139). The lime is little grown in California but considerably in South Florida.

D — THE POMELO

147. The pomelo tree is a little larger than the orange tree; it is now extensively cultivated in southern Florida and California. The fruit, which is very large and resembles the orange in appearance, though paler in color, is borne in clusters of 3 to 15, hence the common name "grape fruit." A well-marked variety, with pear-shaped fruit, called shaddock is little cultivated. The fruit of the pomelo is esteemed for dessert and as a promoter of digestion. The culture practiced is much the same as for the orange. The varieties are budded on seedlings of the pomelo or the sweet or sour orange. The tree is more readily injured by cold than the orange tree.

SUMMARY OF THE PRECEDING SECTION

1. The citrous fruits are grown commercially in the United States only in central and southern Florida, the

delta region of the Mississippi river, and in California. Only in the southern parts of Florida and California do the trees escape damage from freezing (133).

2. The orange is mostly propagated by budding on seedlings of the sour orange, the "rough lemon," or *Citrus trifoliata;* the latter is used in sections where the first two suffer from cold (133).

3. The orange succeeds best on deep, rich, well-drained soil. In parts of Florida it is extensively grown on sandy soil, well fertilized (137).

4. Orange trees are planted in the orchard when 3 to 5 years old from the seed. The trees are commonly grown 24 to 40 feet apart, but those worked on trifoliata stocks may be set closer (138).

5. Orange orchards are commonly well cultivated during the growing season. In Florida, cultivation often ceases after the summer rains begin (139).

6. The orange harvest begins in October in the Gulf region; in California it commences a month later. The fruits are cut from the tree, "wilted" a short time, wrapped in tissue paper and packed in boxes with moderate pressure (140).

7. Orange trees are protected from cold in the Gulf region by banking earth about the trunks, or by building sheds over them. Sometimes heat is used in the sheds (141).

8. Scale insects are the chief enemies of the orange tree. These are held in check by various caustic washes (142).

9. The lemon is less resistant to cold than the orange. It is grown in the United States in the southern parts of Florida and California (143). Its culture is very similar to that of the orange (144).

10. Lemons are cut from the tree before maturity, and as fast as they attain a given size. They are mostly harvested in winter, and are cured in special buildings (145).

11. The lime thrives on poorer soil and nearer salt water than other citrous fruits. It is grown in the United States chiefly in south Florida (146).

12. The pomelo resembles the orange in form and appearance, but is paler in color and much larger. The fruit is borne in clusters. It is rather extensively cultivated in south Florida and California. Its culture differs little from that of the orange (147).

SUGGESTIONS FOR LABORATORY WORK

1. Within the regions where citrous fruits are grown, students may be required to study the characteristics of the different species and varieties, the insect enemies, etc., as recommended in the section on the stone fruits.

2. The character of the orange, as modified by the climate in which it was grown, may be studied in the local market in all localities. The structure of the Navel orange, as compared with other varieties, may also be studied, as well as the methods of packing, varieties, etc.

3. The different species of citrous fruits may be studied in the local market.

Section 5.— The Nuts

148. Present condition and prospects of nut culture. Little attention has thus far been given to the cultivation of nut trees in the United States or Canada. Several kinds of nuts are common in our markets, but the chief supply of native nuts still comes from wild trees. The consumption of nuts is increasing, while the forest areas are rapidly

diminishing, and the cultivation of nuts is certain to increase in importance in the future. Several of the nut trees are valuable for timber; others thrive on land that is worth little for farming. The time required for most nut trees to produce paying crops will tend to prevent overplanting, while the good keeping qualities of nuts render them a safe crop to grow.

The commercial production of nuts offers a promising field to cultivators possessing suitable land in a favorable climate. Most nut plantations in this country have thus far been made of seedling trees. As these are extremely variable, the highest success cannot be hoped for in this way. Now that successful grafting methods have been found, there is less excuse for planting seedlings. Named varieties may be had that bear freely nuts of superior quality, and only those, or meritorious wild trees, should be propagated for the commercial nut orchard. The leading nurserymen now list the principal nut trees, and some named varieties are offered. The number of the latter will increase with the demand. All of the native wild nuts are decidedly variable, and forms much superior to the average are occasionally found. With the exception of the almond, all of the nuts cultivated in this country have monœcious flowers, i. e., the stamens and pistils are produced in different flowers on the same plant.

A — THE PECAN

149. The pecan (*Hicoria pecan* or *Carya olivæformis*) is the most important native American nut. The fruit is largely used for dessert and by confectioners; the commercial demand for it is rapidly increasing.

The tree, in its natural habitat, sometimes attains im-

mense size, and the very tough and heavy wood, which resembles that of the common hickory, is much used for purposes requiring great strength and elasticity. Like the walnut, the tree has a strong tap-root while young, which renders it difficult to transplant successfully. The tap-root is often cut off by digging down on one side of the tree the year before the transplanting is contemplated.

150. Fruiting habit. The pecan, in common with all of the hickories, bears its male and female flowers separately upon the growing shoots; the male flowers in slender catkins at the base of the shoot, and the female flowers near its apex, the fruit becoming lateral by the continued growth of the shoot. The fruit is therefore borne near the base of the young wood.

The trees may yield paying crops of nuts at 10 years old, and the crops increase for many years. A tree of full bearing age may yield from 1 to 20 bushels annually.

151. Cultural range. The pecan is indigenous throughout most of the valleys of the Mississippi and its larger tributaries, and eastern and central Texas, extending southward into Mexico, but nowhere reaching the Gulf coast. Commercial plantations have been made over much of this region and also in the southern Atlantic states, New Mexico, California and Oregon. The trees are not productive in the east far north of the Potomac and Ohio rivers.

152. Soil requirements and propagation. The moist clayey and sandy loams of river bottoms, subject to occasional overflow, are peculiarly adapted to the pecan tree. It also thrives on sufficiently moist and rich uplands. The soil should be well drained. Grafting of the pecan is less successful than of most fruit trees. Crown-grafting on pecan seedlings an inch or two in diameter, in early spring,

with terminal-bud cions, and without wax, has been most successful. The stock should be cut off smoothly at the crown, and grafted by splice or side-cleft graft, according to the size of the stock; but one of the splice surfaces should expose the pith. The grafted crown is mounded with moist earth to the top bud of the cion, to prevent drying.

Ring-budding on the new wood of second-year seedlings is fairly successful when not followed by drought or heavy rains.

To produce seedlings, the nuts may be planted in autumn, in well-drained soil, but where mice and squirrels are troublesome, they are preferably stratified in autumn and planted as early as the ground can be worked in spring. The growth of the young trees should be encouraged as far as possible the first season.

153. Planting and cultivation. The trees of most pecan orchards have been planted 40 to 50 feet apart, but 60 feet would probably be a safer distance. Ungrafted seedling trees may be planted closer, with the idea of removing the unprofitable ones as they become known. Formerly, nuts were often planted where the trees were desired, but latterly the trees have largely been transplanted at 1 or 2 years old from nursery rows. The tap-root of the one-year-old pecan tree is usually much longer than the stem, but it may be moderately shortened without perceptibly checking the growth.

The success of the orchard depends much upon a vigorous growth of the trees the season after transplanting, hence the soil should be made very rich, and be thoroughly prepared. The ground is usually cropped with hoed crops for 4 or 5 years; and some growers continue the cropping indefinitely. The soil should be kept in good fertility.

154. Pruning the pecan does not appear to be generally practiced, but it is said that the trees endure pruning well. Since the fruit is borne only on the new wood, it would seem that, at least in old trees, pruning might be beneficial by increasing the number of new shoots.

155. Harvesting and marketing. The fallen nuts are commonly gathered at frequent intervals. Sometimes the dropping is hastened by beating the branches with poles. The nuts should not become wet, as this would injure their appearance and quality. They should be dried somewhat, before storing in bulk. Most pecans of medium size and below, are polished by friction in revolving barrels before marketing. At present, the demand for the larger thin-shelled nuts for seed is so great, that few reach the retail market. Fifteen to 20 cents per pound is a fair market price: a bushel contains 44 to 50 pounds.

156. Parasitic enemies. The hickory-shuck worm *(Grapholitha caryana)* is perhaps the most serious insect enemy to the pecan. The larva penetrates the hull and young nut, causing premature dropping. The infested nuts should be promptly gathered and burned. The fall web-worm (*Hyphantria cunea)* is injurious to the foliage. It may be controlled by burning the webs as fast as discovered with a torch attached to a pole, or by spraying with an arsenite. The hickory twig-girdler *(Oncideres cingulatus*) sometimes troubles the pecan by girdling the twigs, causing them to be blown off. The fallen twigs should be promptly burned. Certain borers injure enfeebled trees; the only remedy is to destroy such trees.

157. Other nut trees allied to the pecan. Several other species of the genus *Hicoria* that bear edible nuts are native in northern United States. The shellbark or shagbark hick-

ory (*Cary alba* or *Hicoria ovata*) has produced many wild varieties much superior to the average in size and quality. Some of these have been planted for their nuts. Now that successful methods of grafting the hickory are becoming known, the cultivation of this species may become more popular in the north.

B — THE CHESTNUT

158. The American chestnut (*Castanea Americana*) is a favorite among our native nuts, owing to its tender shell and sweet meat. The nuts are extensively marketed from wild trees throughout its habitat, and increased attention is being given to its culture. The European chestnut (C. *sativa*) and the Japanese chestnut (*C. crenata*) have been introduced and are cultivated to some extent.

Two species of chinkapin (*Castanea pumila* and C. *alnifolia*) are more or less dwarfed trees, and bear small, early-maturing nuts, that are quite largely marketed from wild trees in parts of southern United States.

The American chestnut is a large tree; the European chestnut is a smaller, lower-branched tree, and the Japanese species is still smaller, and of a compact, symmetrical habit. The nuts of the foreign species are larger than those of the American, but they are more astringent and less sweet.

159. Cultural range. The American chestnut is native from southern Maine to Delaware and along the Alleghany Mountains to northern Alabama, extending to the Atlantic coast in North Carolina; also westward through southern Canada to southern Michigan, southern Indiana and Illinois, through Tennessee, Kentucky and Mississippi to Louisiana. Its area has been extended slightly by plantings, but the southern range appears to be receding to the

northward. The foreign species are less hardy than the native.

160. Fruiting habit. The pollen-bearing flowers of the chestnut grow from the axils of successive or alternate leaves on the young shoots, opening in early summer, in long catkins which bear fragrant pollen. The pistillate or female flowers grow from the axils of the leaves on the more extended shoot, in four-pointed burs on stiff spikes. The female flowers are thus developed on later and younger wood than the male. Usually only 1 to 3 flowers near the base of the spike produce nuts. In the American chestnut two to seven nuts are commonly borne in a husk. The intermingling of pollen from different trees is thought essential to productiveness by some growers.

Ungrafted trees of the American chestnut commence bearing at 12 to 20 years old; grafted ones at 2 to 7 years after grafting. Wild trees differ greatly in fruitfulness, the more productive ones yielding regular crops of one or more bushels per tree. The Japanese chestnut bears youngest and most freely of all.

161. Soil. The native chestnut is usually found on high, sandy land, gravel ridges or mountain slopes, and generally on soil nearly or quite free from limestone. On deep prairie soils and alluvial bottom lands it is short-lived. It is thus suited to land not specially valuable for farm crops.

162. Propagation. The chestnut is readily propagated by planting the nuts. These should be stratified in autumn, before becoming dry, in moist sand and kept over winter in a cool cellar or buried in the ground. They should be planted an inch or two deep in early spring. The chestnut may be grafted on any species of its own genus and on some of the oaks. Most American chestnut orchards have

been formed by cutting down native chestnut groves and grafting sprouts from the stumps. Ordinary grafting methods, carefully performed, are fairly successful. In budding, dormant buds are usually inserted when the bark peels in the spring, in shoots of the previous year. Rank-growing grafts should be checked by pinching, and if exposed to winds they should be tied to stakes to prevent their being blown off. The chinkapin has been used to some extent as a stock for the native and introduced chestnuts.

163. Orchard treatment. The orchards grown from grafted sprouts are cared for by cutting out brambles and superfluous sprouts, or pasturing with sheep, and by guarding the trees from fire. Planted trees of the American species should be set 40 to 50 feet apart; those of the foreign species may be set somewhat closer. The ground may be used for other crops until the trees shade it, but these will thrive best if the soil is kept well cultivated and moderately fertile. Little pruning is necessary. The burs on some trees of the foreign species may require thinning to prevent overbearing.

164. Preparing for market. The nuts are prepared for market by pouring boiling water over them in a suitable vessel, as soon as gathered. By stirring the nuts in the hot water, the wormy ones will float and can be removed. The eggs and larvae of insects are destroyed by the heat, and the kernel of the nuts is rendered more tender. After 15 minutes the water should be poured off and the nuts spread for drying. Scalded nuts will not germinate.

165. Harmful parasites. Several species of curculio infest the chestnut. Scalding the nuts (164) tends to keep these in check. Certain leaf diseases may probably be prevented by spraying with Bordeaux mixture.

C—THE WALNUT

166. The species. Only one species of the walnut, viz., the so-called English or Persian walnut (*Juglans regia*) is cultivated commercially for its nuts in North America. The native black walnut (*J. nigra*) and the butternut (*J. cinera*) are prized for their timber and for shade, and their nuts are frequently gathered for market from the wild trees. The trees of the species named grow to a large size and are long-lived. The wood of the black walnut is greatly prized for cabinet work, owing to its deep brown color.

167. Cultural range. The English walnut is more or less cultivated in sheltered locations and on rich soil from Southern New York southward to Northern Georgia, and westward across Tennessee and Kentucky to the Mississippi river. In Southern California its culture is more general, and in certain locations it proves very profitable. The tree is fastidious as to conditions and is productive in comparatively few localities. The soil should be rich, moist and well-drained. In California it is most successful in villages within 30 miles of the coast, and where ground water is within 10 to 15 feet of the surface.

168. Fruiting habit. The staminate flowers of the walnut are borne in single catkins, from wood of the previous season, and the pistillate ones at the ends of short branches.

In California the trees begin to fruit at 4 to 10 years old; in the Atlantic states at 10 to 20 years. Two to 5 pounds of nuts per tree is an average crop for the second bearing year. Some 20-year-old trees in California yield 3 bushels per year. In Southern California, the crop begins to ripen from the tenth to the last of September.

The admixture of varieties for pollination is regarded as important.

169. Propagation. Most American orchards of the English walnut consist of seedling trees. The largest, thinnest-shelled nuts, from trees that combine hardiness and productiveness, and that start growth late in spring, should be chosen for planting. These may be stratified over winter in moist sand, and as they germinate in spring, the sprouted nuts may be planted on deep, rich, well-drained soil, 1 foot apart in rows 4 feet apart, and covered about 2 inches with fine soil, well firmed about the seed. The seedlings should grow sufficiently for budding the first season, but if to be planted in the orchard without budding, they are commonly left in the nursery 2 or 3 years. The trees may be budded by either the shield or ring method. Cleft grafting has also been successfully practiced.

170. Orchard culture and pruning. The trees are planted about 40 feet apart each way. Clean culture is advised for the first few years, though, if well fertilized, the ground may be used for low-growing hoed crops or for the smaller and shorter-lived fruit trees.

California growers prune off only those limbs that would interfere with cultivation. Wounds should be waxed to keep water from the pith.

171. Harvesting, curing and marketing. In some localities, the ripe hulls open on the trees, permitting the nuts to fall. In this case, the ground beneath the trees is cleared of leaves, and the fallen nuts are gathered once or twice a week and taken to the drying-house. Young trees are jarred to promote the dropping of the nuts. Beating the trees with poles is not advised. Where the hull does not open, the nuts are left on the ground until the hull becomes brown, when it is removed by hand or by light pounding. Shells discolored by the hulls are washed.

The nuts are dried by exposure to the sun on platforms or trays, or in large orchards, by artificial heat. Three days of sun exposure, or 6 or 7 hours drying at 200° F., cures them sufficiently so that the meats remain fresh several months in a dry, cool place.

The nuts are commonly marketed in sacks holding about 120 pounds. Some growers grade the nuts according to size. The prices received by growers range from 4½ to 20 cents per pound.

172. Introduced walnuts. Three other species of walnuts, viz., *Juglans Sieboldiana*, *J. cordiformis* and *J. Mandshurica*, have been introduced into the United States from eastern Asia, but are not yet grown commercially. The first two promise to be valuable in California. Several hybrids between different species of walnuts have been reported.

D — THE ALMOND

173. The almond (*Prunus Amygdalus*) resembles the peach in habit of growth, and the nut is the pit of a peach-like fruit, in which the fleshy part is thin and hard and splits at maturity. The almonds are divided into two classes — the bitter and the sweet. The sweet class includes hard-shell and soft-shell types, of which the latter produce the edible almonds of commerce.

174. Cultural range. The successful culture of the almond in North America is limited to a few comparatively small districts in California, Utah and Arizona. The tree is nearly as hardy as the peach tree, but the flowers open so early that they are almost invariably destroyed by frost, except in the districts noted. The most successful almond orchards in California are on "bench" or hillside situations, far enough from salt water to escape fogs, and with aspects that are little subject to spring frosts.

175. Fruiting habit. The almond closely resembles the peach in its manner of flowering and fruiting (114). The tree comes into bearing at 2 to 4 years from budding, and reaches mature fruitage at 7 to 10 years of age. Five pounds of hulled almonds per tree is reported a good average crop for an orchard in California. The nuts begin to ripen about the middle of August. The admixture of varieties for pollination is regarded important.

176. The soil for the almond should be light, warm and well drained. The tree will endure much drought, but only yields good crops on rich, well-watered soils.

177. Propagation. The almond is chiefly propagated by budding on seedlings of sweet or bitter, hardshell almonds, though peach stocks are sometimes used. The seedlings may be grown as described for the peach (115). The trees may be planted in the orchard the spring after budding, or the following spring.

178. Planting and pruning. The trees should be planted at least 24 feet apart each way. The young trees are commonly cut back at planting to form a low head. The branches are thinned, leaving about five, and the following winter, these are cut back to encourage them to branch near the trunk. The next winter the trees are pruned to a vase form; henceforward only the inner branches are thinned out as they become too thick.

179. Preparing the crop for market. In sections with a very dry summer atmosphere the hull opens readily, exposing the unstained nuts ready for market. In regions with a moister atmosphere, the more or less stained nuts are bleached by sulfur fumes. The nuts are first well dried, then lightly sprayed with water and treated to the sulfur fumes, which do not penetrate to the kernel. More

or less of the nuts have adhering hulls which are separated by a machine called an almond huller. Nuts stained by rain cannot be bleached by sulfur, and must be sold for confectioners' use. The quality of almonds depends upon the smoothness, symmetry and plumpness of the kernels.

180. Parasitic enemies. The almond trees of California are often injured by the red spider (*Tetranychus telarius*), which may be destroyed by spraying with a caustic solution. This may be made by boiling 3 pounds of sulfur and 2 pounds of caustic soda in 2 gallons of water; adding when the sulfur is dissolved, 25 pounds of whale-oil soap, diluting with enough water to make 100 gallons after the soap is dissolved by continued boiling.

A shot-hole fungus (*Cercospora circumscissa*) is often destructive to the foliage of the almond in California. Three or more sprayings with ammoniacal solution of copper carbonate[1] are recommended for this disease. The first treatment should be given as soon as the leaves appear.

E—THE HAZEL

181. The hazel (*Corylus*) has been little cultivated in North America, though two native species are widely distributed. In Europe, two species are extensively cultivated and yield most of the hazel nuts and filberts of our markets. Our wild species are quite variable, and individual plants bearing nuts of good size and quality have been reported from many places. The species are hardier than most of our cultivated fruits, and are worthy the attention of horticulturists in severe climates. The suckering habit of the plant is perhaps its most serious objection, though it is

[1] For directions for making the ammoniacal solution of copper carbonate, see "Principles of Plant Culture."

probably little worse in this respect than the raspberry. The dwarf habit of our native species commends them for cultivation in small grounds. Some foreign species attain the size of small trees.

182. Fruiting habit. The staminate flowers are produced in catkins from the previous season's growth, and the pistillate ones, which form a star-like tuft of crimson stigmas, grow at the base of the catkins (Figs. 35, 36). The pistillate flowers sometimes bloom later than the staminate ones on the same plant, rendering it unfruitful unless pollen is received from another plant. The hazel commonly bears considerable fruit the fifth or sixth year after planting.

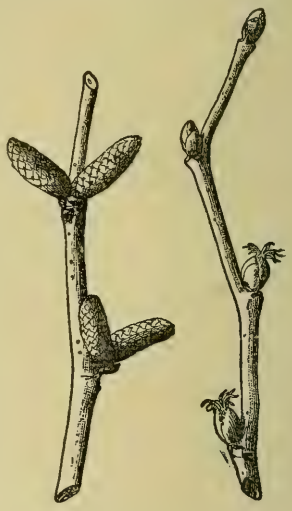

Fig. 35. Fig. 36.

Fig. 35. Staminate flowers of the hazel.

Fig. 36. Pistillate flowers. (From Bailey's "Pruning Book.")

183. Propagation and orchard culture. In Europe, the hazel is propagated by seed, layers, suckers, cuttings and grafting. Nursery plants are generally grown from cuttings 8 to 10 inches long, from the previous year's wood. If packed in moist sand, the cuttings become well rooted in one season, and can be transplanted to the nursery, where, during the next two seasons, the plants are trained to a single stem.

The hazel thrives in nearly all soils except stiff clay or dry sand. A light loam with dry subsoil gives the smallest growth of wood and the largest yield of nuts. The trees

are set 10 feet apart each way, or sometimes nearer in the row. The shoots are thinned by summer pruning, and those left are cut back toward the end of winter. The fruitful limbs are cut back nearly to the buds of the female flowers.

184. Harvesting and marketing. The nuts are permitted to become fully ripe, as is indicated by the brown color of the shell and the readiness with which they may be jarred out of the husks. The husks are then gathered and spread in a loft for a few days to dry when they are packed, without shelling, in casks, with a slight sprinkling of salt to keep out insects.

185. Insect enemies. A curculio belonging to the genus *Balaninus* lays its egg in the young nut in summer, and the larva hatching from it causes the well-known "wormy" hazelnuts. This insect could doubtless be controlled by the methods used in combating the plum curculio (99).

SUMMARY OF THE PRECEDING SECTION

1. The consumption of nuts in North America is increasing, while their production is decreasing, owing to the clearing of the wild lands. The culture of nut trees is, therefore, assuming importance (148).

2. The pecan is the most important nut native to the United States (149).

3. The pecan is chiefly cultivated in the Mississippi Valley, the Atlantic states south of the Ohio and Potomac rivers, and in California and Oregon (151).

4. The pecan thrives on the rich, moist loams of river bottoms. Varieties of it are propagated by grafting on pecan seedlings (152).

5. Pecan trees should be planted 40 to 60 feet apart, on

rich land, thoroughly prepared. The soil between the trees may be planted with hoed crops (153).

6. Pecan nuts are gathered as they fall; they should not become wet; those of medium size and below are polished before marketing (155).

7. Three species of the chestnut are cultivated to some extent in eastern United States; the native species is hardiest of the three, and produces the sweetest nuts, but the two introduced species produce larger nuts (159).

8. The chestnut thrives on high, sandy land, gravel ridges or mountain slopes (161). The trees are grown from seed, and improved varieties are perpetuated by ordinary grafting methods (162).

9. The soil of the chestnut orchard is preferably kept well cultivated and moderately fertile (163).

10. The English or Persian walnut is cultivated to some extent in eastern United States, but principally in southern California. The trees are productive in only a few localities (167).

11. Trees of the English walnut are seldom grafted; the largest, thinnest-shelled nuts from hardy and productive trees are commonly planted (169).

12. Trees of the English walnut are planted about 40 feet apart each way. The ground should be cultivated; if well fertilized, it may be planted with hoed crops, or the smaller fruit trees (170).

13. The nuts are gathered as they fall; if the hulls do not open, they are removed by hand, or by light pounding. The nuts must be dried before being stored in bulk (171).

14. The almond is successful in the United States only in a few districts in California, Utah and Arizona (174). The tree resembles the peach tree in many respects (175).

15. The almond is chiefly propagated by budding on seedlings of the sweet or bitter, hard-shell almond (177). The trees should be planted at least 24 feet apart, on light, warm, well-drained soil (176, 178).

16. The quality of almonds depends upon the smoothness, symmetry and plumpness of the kernels. In regions having a moist atmosphere, the nuts are bleached with sulfur fumes to restore their brightness (179).

17. The hazel has been little cultivated in North America, but the hardiness of the plant commends it for northern localities where few fruits can be grown (181).

18. The hazel may be readily propagated by cuttings and thrives on nearly all soils (183).

SUGGESTIONS FOR LABORATORY WORK

1. Ascertain the species of nuts sold in your local market, the price at which each is sold, and the locality whence each came.

2. Ascertain the species of nut trees that are native in your locality.

3. Require the students to study sample trees of the different kinds of nuts, so far as they are available, until each can name every one at a glance.

4. Practice grafting the different nut trees, so far as practicable.

5. Study the variations of the wild nuts produced in your locality, and require each student to select his ideal type, giving reasons for his choice.

CHAPTER III

THE GRAPE

186. The grape is rapidly becoming one of the principal American fruits. The varieties now chiefly grown in this country are of American origin and have nearly all been produced within the past half century, mainly from the following species:

(a) *Vitis Labrusca*, the northern fox grape, which is the parent of the Catawba, Isabella, Concord, etc.

(b) *Vitis œstivalis*, the summer grape, the parent of the Clinton grape and others of its class.

(c) *Vitis cordifolia*, the winter or frost grape, with its variety, *riparia*, is the more common wild grape of the northern states.

(d) *Vitis Vulpina*, the southern fox grape, the parent of the Scuppernong variety.

Formerly many experiments were made in this country with the European grape (*Vitis Vinifera*), but this species proved too subject to disease in the east. It is much grown in the far southwest.

Most species of the grape hybridize readily, and many of our cultivated varieties are hybrids. The hybrids between the European and American grapes have generally proved unsatisfactory through their liability to disease.

187. Soil and exposure. A warm and prolonged summer temperature is essential to the development of the finer qualities of the grape. In the northern states, a southern exposure, in localities especially exempt from untimely frosts, and a perfectly-drained, light, loamy soil are most

favorable. Rather steep hillsides may be used for the grape by terracing.

188. Propagation. The grape is readily propagated by layers and cuttings and less readily by grafting. Seedlings are rarely grown except to obtain new varieties.

(a) *By layers.* New shoots of most varieties of the grape, layered before midsummer, usually root freely the first season. This method forms a convenient way for the amateur to propagate a few vines, and the superfluous shoots from the base of bearing vines may be used for this purpose. But where vines are wanted in large numbers, and of varieties which do not readily root from cuttings, vines should be planted expressly for layering. In this case, the soil should be made very rich to produce a vigorous growth of shoots. These parent vines should be planted 6 or 7 feet apart and should be permitted to grow 2 or 3 years, or until 2 or 3 vigorous shoots are produced, before layering begins. It is well to train these shoots to upright stakes. About the time the leaf buds begin to open, the strongest of these shoots may be layered by putting down so much of each shoot as has strong, well-developed buds, in a straight trench about 5 inches deep, in which it is held in place by pegs or stones. When shoots from the buds on the layered cane have grown a few inches, the cane should be lightly covered with earth or compost, and it is well to mulch it with a little loose, damp moss. Too much earth added at first may cause rotting of the young stems. Usually not more than 6 plants should be raised from one cane, and if the shoots of these grow unequally, the more vigorous ones should be pinched. In the meantime, one or more young shoots, the number depending on the strength of the parent plant, should be

trained upright, for layering the next season. The plants from the layered cane should be well rooted before winter. They should be taken up in autumn, separated by cutting the parent cane between the plants, and kept through the winter by being buried in a well-drained place in the open ground, or in a cool, moist cellar.

The layering process may be repeated in successive years. Should the parent plant show reduced vigor, layering should be omitted one season to permit it to recuperate.

(b) *By cuttings.* Most varieties of the grape are readily propagated from cuttings of the previous year's growth. The cuttings are preferably made in autumn. It is customary to use cuttings containing two nodes, cut shortly below the proximal node and an inch or two above the distal one. The cuttings may be buried a foot or more deep, in well-drained soil in autumn, and some varieties are found to root better if buried with their proximal end uppermost. The canes may be buried during winter and the cuttings made in spring, but it is usually more satisfactory to make the cuttings in autumn.

The cuttings should be planted in spring, in well prepared soil, and up to the distal bud. They may be placed 4 or 6 inches apart in rows, preferably running north and south, and the rows should be far enough apart to admit of convenient cultivation. Well-crumbled soil should be compactly pressed about the cuttings. To facilitate the latter process, the cuttings are often laid against the sloping side of a trench. This is then filled with the soil, which is pressed about the cuttings with the foot.

It is important to shade the cuttings from bright sunshine. This may be done by supporting a board, 8 or 10 inches wide, on light stakes a short distance above the row,

and the shading should be so placed over the row as to intercept the sun's rays during the warmer part of the day. It should be left on until after midsummer, when it is preferably removed.

The grape is often propagated under glass, and over bottom heat, from single-bud cuttings. For this purpose, the wood should be cut in autumn and kept through winter as before described. The cuttings are made and planted during March and the first part of April. They may be of various forms. An improved method is to cut the distal end one-fourth inch above the bud, and the proximal end about two inches below the bud. These cuttings are planted at an angle of 45 degrees, so that the bud, which points upward, just appears above the surface. Care should be taken to prevent the drying of the cuttings during their preparation and insertion. When the cuttings are to be grown in hotbeds they are usually placed in small pots, but when intended for the propagating house, they may be grown directly in the beds if preferred. In making the propagating bed for grape cuttings, a thin layer of potting soil is sometimes placed in the bottom of the bed to nourish the rooted cuttings until they can be potted. After potting they are allowed to grow until well rooted before planting out.

The grape is also sometimes propagated from green cuttings, but, as vines thus grown do not always mature well before winter, they are objected to by many.

(c) *Root grafting.* The grape is now extensively root-grafted in some localities. A short section of root is cut wedge-form at the distal end and the wedge is inserted into the proximal end of a cutting made as directed for single-eye cuttings. The union is then wound with a grafting

plaster, after which the grafts are set upright in boxes about 1 by 2 feet and 2 inches deep, and placed in bottom heat, as described for single-bud cuttings. The grafts require less care than do cuttings.

(d) *Crown grafting* the grape in the open ground is sometimes practiced, though the attempt is often unsuccessful. The graft is inserted in the crown of the root, or in the root below the crown, either early in spring, before the "bleeding" season, or in autumn. The cleft graft is mostly used and the parts are bound together without waxing. In all cases, the union should be protected from the weather, either by covering directly with soil or, when the work is done in autumn, by first covering with an inverted flower pot and burying this in soil.

Young vines grown from layers or cuttings are commonly left in the nursery one season before being planted in the vineyard. They should be trained to a single shoot, which should be tied to an upright stake. Strong vines of vigorous varieties often make a growth of 6 or more feet the first season.

189. Preparation of soil and planting. The soil for the vineyard should be well prepared by thorough plowing and harrowing, and by rolling if need be. A moderate degree of fertility is best. The rows may be laid off as directed for laying out orchards (26). They may be 7 or 8 feet apart, according to the vigor of the variety; or the rows may be placed uniformly eight feet apart, and the distance between the vines varied to suit their vigor. The less vigorous varieties, like Delaware and Catawba, may be planted 7 or 8 feet apart, while the stronger-growing varieties, like Worden and Concord, may be set 9 or 10 feet apart. When planted on sloping ground, the rows should be run at right angles to the slope. Where the slope is suf-

ficiently steep to require surface drainage, an occasional row should be omitted to give room for drains. The vines may be planted in spring or autumn, but in the latter case the tops should be covered with earth until spring. The canes should be cut back to 2 or 3 buds at planting, and by whatever method the vines are to be trained, the strongest shoots should be tied upright to a stake the first season, all other shoots being rubbed off as they appear.

190. Fruiting habit. The grape vine fruits chiefly on shoots from the preceding season's growth. Blossoms appear at a few of the more proximal buds of such shoots soon after growth starts in spring. Other blossoms often appear later, farther out on the shoots, but these later flowers are probably formed in spring, and seldom mature fruit. Shoots from wood two or more years old may also blossom, but these seldom mature good bunches. The grape, unlike the tree fruits, produces no distinguishable flower buds, but the embryo leaves and flowers are enclosed within the same bud scales.

The vine commonly begins bearing at three years after planting, and should produce one or two bunches on each shoot that is permitted to grow.

191. Pruning and training. The grape vine is a rampant grower and in its wild state climbs upon trees, fruiting on its outermost branches. In culture, we are compelled to restrict this rampant growth; hence severe cutting back is necessary, and some method of pruning must be employed that produces annually a number of vigorous canes near the base of the vine. The European grape fruits freely in many countries when the new growth is permitted to spread upon the ground, but the American species are satisfactory only when the young shoots are supported upon a suitable trellis.

Pruning refers to the removal of parts of the vine. *Training* refers to the placing upon the trellis of the parts that are left.

A growing, leafy branch of the grape vine is commonly called a *shoot.* A ripened shoot is called a *cane.* A branch two or more years old is called an *arm.* A branch of an arm older than a cane is called a *spur.*

A shoot normally starts in spring from each bud of last year's wood, and continues to grow throughout the summer. At each leaf of the shoot a bud is normally produced, from which new fruit-bearing shoots may grow the next spring. If all these buds were allowed to remain, the vine would produce the next season more flower clusters than it could properly mature, which would result in a large number of poorly-developed bunches, and a weakened vine. The canes are therefore cut back until they bear only as many buds as experience has shown the vine can properly develop. The number of buds that should be left will depend upon the variety, the age and vigor of the vine, the character and exposure of the soil, the cultivation given and the method of pruning and training adopted. Experience must be the chief guide. A mature vine of the Concord grape, which is a vigorous and prolific variety, planted 9 or 10 feet from its neighbors, on good soil, with favorable exposure, pruned and trained by any of the ordinary systems, will usually develop 30 to 60 clusters weighing one-fourth to half a pound each. It follows that such a vine should have from 15 to 30 bearing shoots, and hence should be cut back at the annual pruning to from 15 to 30 buds, the number depending on the health and vigor of the vine. All the wood of the previous season's growth is therefore cut away, except sufficient to contain 15 to 30

buds. The properly-pruned vine does not, therefore, increase in size in proportion to the annual growth, as do most other perennial plants. These buds may be left on one or more canes according to the method of pruning employed. A vine that completely covered the trellis in autumn will need to be cut back to one rather long cane, or two or more shorter canes.

192. Methods of training. It is important that the operations of pruning and training be kept distinct in the mind. In the winter or spring pruning, the vine may be cut back in such a manner as to leave only the ripened shoots of the previous year (*canes*) (191) for producing the next season's crop, or wood older than that of the preceding year (*arms*), with stubs of younger wood (*spurs*), may be left; or a combination of canes, arms and spurs may be left, and all of these methods of pruning may be used with any system of training.

Numerous more or less distinct methods of training have been practiced and described, but all may be referred to two classes, viz.: the *upright* methods, in which the shoots are tied to the trellis above the cane, arm or spur whence they grow; and the *drooping* methods, in which the shoots are not tied to the trellis, but hang from the cane, arm, or spur. The upright methods are more numerous than the drooping methods and have been longer in use. They are somewhat more expensive in practice since the shoots require to be tied.

193. The single-post method is the simplest kind of upright training. In this, the canes and shoots are all tied to a single post set near the base of the vine. The merits of this method are its cheapness and that it admits cultivation of the vineyard in both directions. It does not give

sufficient room for the development either of foliage or bunches, and probably favors certain fungous diseases by obstructing free circulation of air about the fruit.

In the other upright systems, two canes or arms are tied to the lower wire or bar of the trellis, so as to extend in opposite directions, and from these the shoots are tied to the trellis as they attain sufficient length. The older methods of this class of training employed arms which continued from year to year, and the shoots were annually cut back to one or two buds (spurs). By this method, a considerable part of the vine remained from year to year; and since shoots grown from old wood are usually unproductive, the fruitfulness of the vine could only be maintained by permitting the spurs to become longer at each cutting back. This is objectionable because it annually reduces the room on the trellis. To avoid these objections, a method has been adopted by which strong canes are substituted for the horizontal arms, thus renewing the entire vine each season, with the exception of the trunk and a few spurs at its summit.

194. The high renewal method, which is now extensively employed, starts the head or branches of the vine 18 to 30 inches from the ground, the lower wire or bar of the trellis being placed at this height. For training by this method, the single strong cane secured from the young vine at the end of the first or second year after planting, is cut back in autumn to the height of the lower wire or bar of the trellis. The next spring (the second year of training) two shoots are permitted to grow from the uppermost buds on this cut-back cane, and all other buds are rubbed off. These two shoots are tied to the lower arm of the trellis and are permitted to grow upward without pinching during the season, being tied to the upper wires

as they acquire sufficient length. In autumn, these canes are cut back to firm and strong wood, which will usually leave them bearing from 5 to 8 buds each. The following spring (the third season of training) these canes are tied to the lower wire of the trellis, and the shoots which grow from the nodes of these canes are tied to the upper wires as they gain sufficient length, and are permitted to take care of themselves after passing the uppermost wire. (Fig. 37.) In the stronger varieties, they often lop over

FIG. 37. Grape vine trained by high-renewal system. (From Bailey's "Pruning Book.")

and reach the ground late in the season, but they should not be cut off unless the needs of cultivation demand it, and then the cutting should be delayed as long as possible. These upright shoots may be expected to bear 1 or 2 bunches each, the number depending upon the variety and the vigor of the vine. Thus the vine commences to bear fruit the third year of training.

The pruning at the close of the third season will consist in cutting off both of the horizontal canes from which the upright shoots grew, as near the trunk of the vine as possible and yet leave two of the stronger upright shoots (which have now become canes) as near the top of the trunk as possible. This reduces the wood at once to two strong canes which have their origin near the top of the

trunk. These canes are now cut back to strong and sound wood, and the process of the preceding year is repeated.

This method of training requires the production of two strong canes near the top of the trunk each season. But as a portion of the wood of the preceding year must be left at each cutting back, spurs are soon formed at the top of the trunk. It often happens that neither of the canes starting from these spurs is strong enough for laying down as a main cane the next spring. In this case, the nearest cane to the trunk that is sufficiently strong is chosen, and the weaker cane near the top of the trunk is cut back to two buds, from which strong shoots may be expected to grow the following season.

As the vine acquires age, a strong shoot may be trained up from the base from time to time and treated precisely as a young vine. The second year thereafter, the old vine may be cut away at the surface of the ground and the younger trunk trained to take its place.

195. The Kniffen system. The principal drooping method of training was first used by one William Kniffen in the Hudson River valley about 1854, and hence has received his name. The original Kniffen system employed a trellis with two wires only, of which the lower wire was usually placed $3\frac{1}{2}$ feet from the ground and the upper about 2 feet above this. A single stem or trunk of the vine is carried directly to the top wire and two canes are trained outward from side spurs at each wire (Fig. 38).

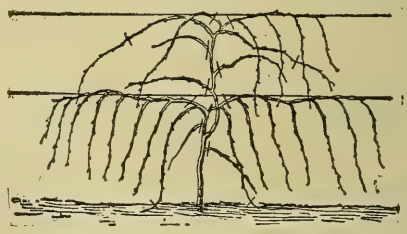

Fig. 38. Grape vine trained by Kniffen system. The cross-marks show where the branches should be cut off in pruning. (From Bailey's "Pruning Book.")

Thus the vine has four horizontal canes tied to two wires instead of two tied to one wire as in the method previously described. These canes are at such a distance from the ground that shoots growing from them hang down instead of growing upright, and hence require no tying. Thus the labor of caring for the vines during summer is greatly lessened.

The pruning of vines trained by the Kniffen system is very similar to that in the upright method described. All is cut away save the four canes which hang nearest the trunk. These four canes are then cut back to strong wood and are tied to the wires the following spring (Fig. 39).

In case the canes nearest the trunk are not strong enough for main canes, they may be cut back to one or two buds (spurs), and the next cane used that is sufficiently strong. The following season, the shoots growing from these spurs may be expected to regain their vigor. As the vine acquires age, it is customary to prune the canes tied to the upper wire longer than the lower ones. In strong varieties like Worden, each of the upper canes may bear 10 buds, and each of the lower ones 5, which gives 30 buds to the vine.

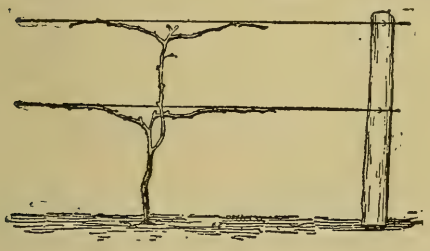

Fig. 39. The vine shown in Fig. 38 after pruning. (From Bailey's "Pruning Book.")

Vines pruned by the Kniffen system are commonly grown to stakes the first two seasons, and the canes are put upon the trellis the third season. The vine is usually carried directly to the top wire the first season of training,

though some growers stop the trunk at the lower wire the third season, carrying it to the top wire the following year.

196. When to prune. The annual pruning may be performed at any time after the leaves mature, until frost leaves the ground in spring. In severe climates, where winter protection is necessary, the pruning is best performed before the grapes are laid down for winter. The work is commonly done with small pruning shears.

197. Summer pruning. Whatever method of pruning is adopted, more or less attention is required during summer to prevent the growth of superfluous shoots. Weak shoots often start out at the base of the main shoots, or of the trunk; these should be promptly rubbed off, unless needed for a special purpose. The flower clusters usually need more or less thinning. Three or more are often formed on a single shoot, while one or two good bunches are all that one shoot should be expected to develop, except in the most vigorous varieties.

198. Trellises for the grape. The most common trellises in use consist of one or more wires attached horizontally to posts set midway between each alternate two vines. Except in very hard and stony land, all the posts are commonly driven but the end ones, which are usually set. For the upright methods, the posts should reach 5 or 5½ feet above the soil; for the Kniffen system they should reach a foot higher. The posts should stand a little higher at first than is necessary for the support of the wires, for they will need to be driven down occasionally as they become loose. The end posts of each trellis should be well braced. Plain No. 12 wire is commonly used, except for the top wire in the Kniffen training, which is usually No. 10. The wires

are generally wound once around the end posts and their ends secured by staples, or bent around the wire forming a loop. They are secured to the intermediate posts by staples driven in far enough so that the wire will not pull through readily, but not so firmly as to prevent tightening the wires. In windy regions the wires should be placed upon the windward side of the posts. It is generally found necessary to tighten the wires and posts as they become loose, and it is wise to tamp the ground about the posts each spring.

For upright training, the trellis is usually begun the fall or winter following the planting of the vineyard. With the Kniffen system it may be delayed a year longer.

199. Tying. Raffia, wool twine, osier willows, green rye straw, corn husks and bass-wood bark are all used for tying. Of these, raffia is perhaps the most satisfactory, though more expensive than some of the others. A stronger material is needed for tying the canes to the wires in the spring than for summer tying.

It is important that the canes be tied to the wires early in spring, to prevent injury to the buds by the moving of the canes by the wind. These canes should be tied firmly, but the shoots tied during the summer may be fastened more loosely.

200. Harmful insects. While the grape is more or less injured by a number of insects, few of these are sufficiently destructive in this country to require special notice. The phylloxera (*Phylloxera vastatrix*), so destructive to the European grape, is but slightly injurious to our native species. The foliage is more or less injured by several large beetles and caterpillars, but as these seldom appear in large numbers, and are rather conspicuous, they are readily controlled.

201. The rose beetle (*Macrodactylus subspinosus*) (Fig. 40) is sometimes very destructive to the foliage of the grape in early summer. While it eats the foliage voraciously, it is not readily destroyed by poisons sprayed upon the leaves. As the beetles are naturally sluggish, they are easily shaken from the vines upon sheets in the early morning, as described for the plum curculio (99).

FIG. 40. Rose beetle, natural size. (After Saunders.)

202. The grape-vine leaf-hopper (*Erythroneura vitis*), improperly known among grape growers as the "thrip" (Fig. 41), is often injurious to the foliage of the grape late in summer. It is a small insect of the sucking class and works chiefly on the lower side of the leaves. The consequent exhaustion of the sap causes yellowish or brownish spots on the upper side of the leaves, which later increase in size, often covering the whole surface. In a severe attack, the foliage over an entire vineyard may appear as if scorched and may even drop, thus greatly retarding or preventing the ripening of the fruit.

FIG. 41. Grape-vine leaf-hopper, enlarged; natural size indicated by short lines. (After Saunders.)

This insect is rather difficult to control owing to its quick movements. Thorough spraying with dilute kerosene, taking care to wet both sides of the leaves, will destroy vast numbers of them. As they are attracted by light, many may be destroyed by carrying lighted torches through the vineyard, and disturbing the foliage to dis-

lodge them. As the insects pass the winter under dead leaves and other rubbish, many may be destroyed by raking these materials from the vineyard late in autumn or early in spring.

203. The principal fungous diseases attacking the grape are the black rot (*Læstadia Bidwellii*), the downy mildew (*Peronospera viticola*), the powdery mildew (*Uncinula spiralis*) and the anthracnose (*Sphaceloma ampelinum*). These all attack both the foliage and the fruit, and are propagated by spores deposited on these parts. They are often very destructive unless prevented by timely treatments.

204. The black rot is one of the most serious diseases of the grape, especially in the south. Some of the symptoms on the shoots are dark, oval, slightly-sunken areas, of which the centers are thickly studded with very small pimples. The affected parts of the leaves are generally between the veins, have rounded outlines and are of a dark, reddish-brown color. The fruits are commonly attacked when nearly or quite full-grown. The part affected is blackened and characteristic pimples appear; the berry shrivels and becomes strongly ridged and the seeds project prominently under the drawn skin; the entire berry is then black, with minute elevations thickly scattered over it. In warm, moist weather the disease progresses very rapidly, greatly reducing the crop in a few days. Individual berries in the cluster often escape harm.

Preventive measures. Three thorough sprayings with Bordeaux mixture, the first beginning as soon as the earlier leaves are expanded, the second after the vines have blossomed, and the third 2 to 4 weeks later, largely prevent the attack. If the weather is warm and wet, later sprayings, 10 to 14 days apart, will be necessary. After the ber-

ries are three-fourths grown, ammoniacal solution of copper carbonate is preferable to Bordeaux mixture, as it stains the fruit less.[1] In the north, where the attacks are not so severe, the treatments need not begin until July 1st, and two later sprayings at intervals of 2 or 3 weeks usually prevent damage.

205. The downy mildew, also called *brown rot* and *gray rot*, is more common than the black rot in the northern states. Like the latter, it is most serious in warm, wet seasons. Some of its symptoms are light-green patches upon both sides of the leaves, which later become yellow, and still later change to brown. As the spots become yellow upon the upper side of the leaf, a frost-like substance projects from the discolored part on the under side. The affection of the leaf is often accompanied by brown, slightly-sunken areas on the shoots. The fruit is often attacked, if at all, before the berries are half-grown. Affected berries first become brown and later are covered with a whitish powder.

Treatment. In localities subject to this disease, an application of Bordeaux mixture should be made when the shoots have grown 6 to 10 inches, to be followed by a second application after the vines have blossomed, and later sprayings should succeed each other at intervals of 2 to 4 weeks, depending upon the season. The later treatments may be made with ammoniacal solution of copper carbonate to prevent staining the fruit.

206. The powdery mildew develops most rapidly in rather dry weather. It is a surface-growing fungus which appears mainly upon the upper surface of the leaves, form-

[1] Directions for making Bordeaux mixture and ammoniacal solution of copper carbonate are given in "Principles of Plant Culture."

ing whitish patches from which the mildew may be rubbed off, disclosing brown tissue beneath. Similar spots appear upon affected berries.

Treatment for this disease may be postponed until the symptoms appear. Bordeaux mixture or ammoniacal solution of copper carbonate, sprayed upon the affected parts, usually prevents serious damage.

207. Anthracnose is often very destructive to the grape. It may appear any time during the growing season, but most commonly affects the berries during the middle and latter part of summer. The shoots are commonly attacked, and the first indication of the disease is a darkening and sinking of small, oval areas extending lengthwise of the stem. These may be very numerous, giving the shoots a speckled appearance. The spots gradually enlarge and the center assumes a gray color, while the dark edges take on a more or less decided tinge of purple. In severe cases, the shoot may be wholly destroyed. Upon the leaf, the disease usually attacks the veins and leaf-stems, producing similar marks to those upon the shoots, but with a reddish-brown color. The disease also often girdles the stems of the clusters, causing an affection known as "ring-around." The berries below this ring do not ripen and gradually shrivel. On the berries the attack is marked by circular, sunken, brown spots, bordered with red or purple.

Treatment. The vines and trellises may be washed during winter or early spring with a solution of sulfuric acid and sulfate of iron, consisting of one hundred parts of hot water, in which is placed as much iron sulfate as the water will dissolve, and one part of sulfuric acid. This solution, which is very caustic, is applied with a swab of rags tied about the end of a stick. The solution blackens the treated

parts, hence the color of the latter is a test of the thoroughness of the work. Applications of Bordeaux mixture during summer for other diseases are also beneficial in preventing anthracnose.

208. Harvesting and packing. The fruit of the grape does not improve in quality after it is removed from the vine, hence it should not be gathered until as mature as it will become in the climate in which it is grown.

The fruit should be picked only when dry. The picker should take the cluster by the stem, cutting it off with a pair of shears and placing it in the picking tray with the least possible touching of the fruit (16).

The grapes should be removed directly from the picking tray to the market package, all imperfect berries being taken off in the meantime. Grapes are commonly packed in the so-called "Climax" basket, which is made of various styles and sizes (Fig. 25). In packing, the greatest care should be used to keep the fruit clean and fresh, to prevent the bunches from being broken and to preserve the bloom.

Grapes intended for long keeping should be stored in a moderately dry apartment in which the temperature is uniform and rather low. The grapes should be as nearly as possible of the temperature of the room when placed in it. Ventilation should be given only on dry days and when the outside temperature differs little from that of the room.

209. Winter protection of the grape vine is essential in climates having severe winters. This is accomplished by laying the pruned vine upon the ground and covering it with soil, straw or corn stalks. The former is most commonly used, as it is cheapest, and does not attract mice.

To prevent breaking the stem, a little earth should be removed from the roots at the base of the trunk in order that the strain of bending may come chiefly on the roots.

SUMMARY OF THE PRECEDING CHAPTER

1. The grapes now grown in the United States and Canada are chiefly of American origin. The European grape is grown extensively in the far southwest (186).

2. The grape requires a warm and prolonged summer temperature. In the north, a southern exposure, free from untimely frosts, and a perfectly-drained, light, loamy soil are most favorable (187).

3. The grape is mostly propagated by cuttings or layers. Root grafting is practiced in some localities; crown grafting is little practiced (188).

4. The grape is commonly planted in rows, 7 or 8 feet apart, the vines being set 7 to 10 feet apart in the row. The soil should be of moderate fertility and well prepared (189).

5. The grape vine fruits chiefly on young shoots from wood formed the preceding season. It commonly begins fruiting the third year after planting (190).

6. The grape vine, being a rampant grower, must be severely pruned. The American varieties fruit well only when the stems are trained upon a suitable trellis (191).

7. The different methods of training the grape vine may be reduced to two, viz., the upright methods, in which the stems are tied low on the trellis, and the shoots are tied above, as they grow; and the drooping methods, in which the stems are tied high on the trellis, and the shoots are permitted to hang from them (192).

8. The most important upright training method is the

"high renewal" (194); the most important drooping method is the "Kniffen" (195).

9. The annual pruning of the grape vine may be performed any time from the maturing of the leaves in autumn until frost leaves the ground in spring (196). Summer pruning is also needed (197).

10. The trellis most in use for the grape consists of one or more wires attached horizontally to posts set midway between each alternate two vines (198).

11. The principal insect enemies to the grape vine in the United States and Canada are the grape-vine leafhopper and the rose beetle. The former is held in check by spraying with dilute kerosene, by carrying lighted torches through the vineyard at night, and by removing the fallen leaves, etc., beneath the vines in late autumn. The latter insect may be destroyed as recommended for the plum curculio (201, 202).

12. The principal fungous diseases attacking the grape are the black rot, downy mildew, powdery mildew and anthracnose. The first three are prevented by spraying with Bordeaux mixture; the fourth, by washing the vines and trellises in winter or early spring with a solution of sulfuric acid and sulfate of iron in water (203, 207).

13. Grapes should be gathered when dry and fully mature, with the least possible touching of the fruit. They are commonly packed in the Climax basket (208).

14. The grape vine may be protected in winter by covering the stems with earth (209).

SUGGESTIONS FOR LABORATORY WORK

1. Ascertain the different species of grape that grow wild in your vicinity.

2. Practice propagating the grape vine by cuttings, layers and grafting, so far as the season permits.

3. Practice pruning the grape, for different systems of training, both on young and bearing vines, so far as the season admits.

4. Practice training the grape by one or more of the upright and drooping systems.

5. Study the diseases of the grape vine and apply the preventives given, so far as practicable.

6. Practice packing the grape in baskets, if the season permits.

7. Practice crossing different varieties and species of the grape vine, so far as the season permits.

CHAPTER IV

THE SMALL FRUITS

210. The small fruits, so-called, include several fruit plants of which the fruits are small in size and grow upon shrubs or herbaceous plants. The term is a cultural one and has no reference to botanical characters. It includes the fruits that are called in common parlance "berries" and also the currant. For convenience we sub-divide the small fruits into (a) the *brambles*, including the raspberry, blackberry and dewberry; (b) the *groselles*, including the currant and gooseberry; (c) the strawberry; (d) the cranberry and (e) a miscellaneous group, including all others commonly classed with the small fruits.

211. Picking and packing. With the exception of the cranberry (273), the small fruits are commonly marketed in small baskets or boxes holding about a quart or a pint (Fig. 42). These are packed in cases or crates to the number of 16, 24, 32 or 48 in each (Fig. 43). The boxes and crates are commonly purchased in the "knock-down"

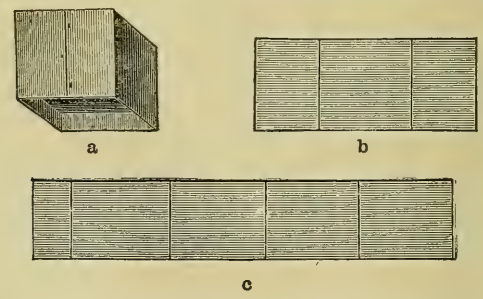

FIG. 42. Berry box and the two pieces of which it is made. A, complete box; b, piece forming the bottom; c, piece forming the sides.

form, i. e., the parts not set up or nailed together, and are put in shape for use on the fruit plantation. Stapling machines are used by large growers for nailing up the boxes.

Boys, girls and women are generally employed for picking the small fruits.

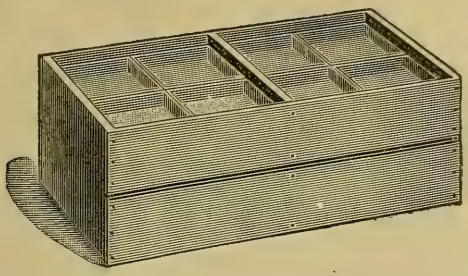

FIG. 43. Case or crate in which the filled boxes are marketed. The empty boxes are commonly placed in the case bottom upward.

The fruits are commonly picked directly into the boxes in which they are marketed, but one quality being made, though strawberries are sometimes assorted during picking into two grades. All leaves, straws or dirt must be kept out of the boxes in picking, and the pickers must be compelled to keep their own rows. The boxes are carried in the field in light, handled trays holding 4 or 6 boxes, and for the bramble fruits, a small frame, in which a box may be placed, attached to a belt, is sometimes buckled about the waist, to enable the use of both hands in picking.

The pickers are commonly paid by the box, though some growers prefer to pay by the day or hour. When paid by the box, the accounts with the pickers may be kept by giving each picker a printed ticket on which a number corresponds to the number of filled boxes delivered, or each picker may be given a card, with his name written on it, on which the number of filled boxes delivered by the picker

may be punched by the foreman with a conductor's punch. In settling with the pickers, the tickets or cards are retained by the foreman.

A small, portable, canvas-covered building or tent is very useful in the small-fruit field, to serve as a temporary shelter for the gathered fruit and for packing.

Section 1.—The Bramble Fruits.

212. The brambles are in a sense intermediate between an herb and a shrub, i. e., the root is perennial, but the stems die nearly back to the crown the second season of their life, after maturing a single crop of fruit. The stems of the cultivated brambles are, with a few exceptions, more or less prickly.

The cultivated brambles include the following botanical species:

(a) The American red raspberry (*Rubus strigosus*).
(b) The European red raspberry (*Rubus idæus*).
(c) The blackberry (*Rubus nigrobaccus*).
(d) The blackcap raspberry (*Rubus occidentalis*).
(e) The northern dewberry (*Rubus villosus*).
(f) The purple-cane raspberry (*Rubus neglectus*).

Rubus neglectus is supposed to be a hybrid between *Rubus strigosus* and *R. occidentalis*. A few other species of Rubus are cultivated to a slight extent in the United States.

The common names "red" and "black," as applied to the fruit of these species tend to be misleading, since white- or yellow-fruited varieties are known in all of the species except *Rubus neglectus*, and there are two species of raspberry in which the fruit is commonly red.

The canes of the first three species grow upright throughout the season. Those of the second three grow more or

less upright during the first part of the growing season, but later the stems droop to the earth, at least near their tips, and if the conditions are favorable, the tips take root in the soil.

As the methods of culture of the different bramble fruits are similar, it is convenient to treat them all at the same time.

213. Propagation. Plants of the first three species above named are readily propagated by suckers from the roots, especially when the latter are cut.

Plants of the second three species are, as a rule, readily propagated by layering the tips of the canes in late summer or early autumn. Plants thus layered should form abundant roots and a strong bud before winter. The time for layering is indicated by the tips becoming slightly thickened and growing without leaves. On well-cultivated soil, many tips will root without assistance in seasons of frequent rains, but the tips are much more likely to root if covered with soil. After rooting, the parent stem may be severed, and the young plants taken up and permanently planted late in the autumn or early the following spring. It is said that better-rooted plants of all of the species may be obtained from cuttings of the roots an inch or more in length, started under glass with mild bottom heat. These root cuttings are preferably made in autumn, packed in sand in shallow boxes and stored for callusing in a cool cellar until February or March, when they are planted in the propagating bed.

214. Planting. The bramble fruits are commonly planted 3 or 4 feet apart, in rows 6 or 7 feet apart. The blackberry and the larger-growing raspberries should be given the wider distance. In handling the young plants care

should be taken not to injure the bud at the crown, as growth of the stem must proceed from this bud.

215. Fruiting habit. In the cultivated brambles the young plant, which is commonly a bud offset from the parent rather than a seedling, develops a single shoot the first season. The following spring, the lateral buds of this shoot that escaped injury during the winter, with the exception of two or three near the base, grow out into leafy branches, of which the terminal and axillary buds develop into flowers. Thus the plants begin to fruit the second year, but the first crop, growing from a single cane, is small. The second crop may be as large as any succeeding one. The flowers are followed by the thimble-like, composite fruits. After these mature, the stem dies back to the basil buds above mentioned, which in the meantime have developed into vigorous shoots destined, in like manner, to fruit and perish the following season.

The fruit consists of a collection of small drupes (drupelets), attached to a common receptacle. In the blackberry and dewberry, the receptacle separates from the plant with the ripe fruit; in the other species the ripe fruit separates from the receptacle.

216. Soil and culture. The bramble fruits thrive on any good farm land and are most continuously productive on land that is maintained in a moderate degree of fertility. On very strong soils, the canes grow to excessive size and yield proportionately less fruit than on moderately fertile soil. The only culture required is to keep the soil free from weeds, and the surface loose. In the suckering species (213), the superfluous suckers should be treated as weeds. Mulching is advisable in localities subject to drought in summer and autumn. Deep plowing between

the rows should be avoided, as it is liable to cut off main roots.

217. Duration of the plantation. The plants of the bramble fruits lose vigor and the crowns become very large after 4 or 5 crops of fruit have matured. It is therefore best to renew the plantation once in 5 or 6 years.

218. Pruning. As each cane (191) of the bramble fruits develops one or more shoots from near its base, the number of canes tends to increase rapidly as the plant acquires age. It is therefore important to thin out the canes after the second year. The number of canes to be left depends upon conditions; probably 3 to 6 would be best for the majority of plantations.

It is customary to pinch the tips of the shoots of the blackberry and blackcap raspberry as they attain the height of 12 to 24 inches to induce a stocky, branching growth. Recent experiments have failed to demonstrate the importance of pinching the raspberry, especially where winter protection is practiced. The pinched canes bore scarcely enough more fruit to pay for the labor of pinching, while the expense of covering them for winter was much increased. Shoots pinched lower than 24 inches yielded no more fruit than unpinched ones. Pinching unquestionably stimulates the production of shoots.

The dead fruiting canes of the bramble fruits are commonly cut off and removed after the berry harvest or before the following spring. Where the raspberry cane-borer (223) is troublesome, it is important to remove and burn the dead bearing canes soon after the fruiting season, to destroy any larvæ they may contain; — otherwise experiments indicate that it is better to postpone removing the dead canes until autumn, or, in case winter protection is not practiced, until the succeeding spring.

219. Trellising. The plants of the bramble fruits are often grown without staking or trellising, but some support, to prevent the canes from undue spreading or trailing, is desirable, especially with the blackberry and the black-cap raspberry. For this purpose, a wire supported 2 or 3 feet high on each side of the row, upon short stakes, or upon a horizontal piece nailed to a single post, is well adapted (Fig. 44). The canes are not tied to the wires, but are directed so that they grow between them. Where winter protection is practiced, the wires may be readily removed for laying down the canes. The cross pieces above the wires are to keep the latter from spreading and the canes from getting out of place.

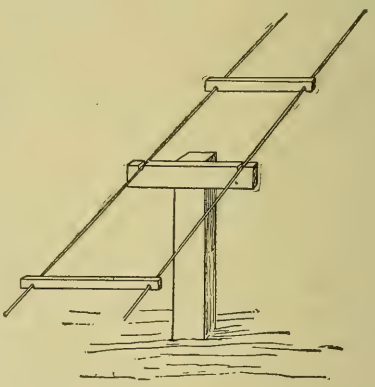

FIG. 44. Trellis for the raspberry and blackberry.

The canes of the dewberry are commonly permitted to creep along the ground. Sometimes the bearing canes are supported on low, horizontal trellises made of lath, to better expose the fruit to light and to aid in gathering it.

220. Winter protection. In climates where the apple and grape suffer in winter, the canes of the bramble fruits are not fully hardy unless protected by a covering of earth or litter. The more common method of winter protection is similar to that described for the grape (209).

221. Picking and packing. The bramble fruits continue to improve in flavor until ripe enough to drop.

They should be gathered a little before this stage of ripeness for market, but raspberries picked for drying are often allowed to remain on the plants until they can be jarred off into a sort of hopper by striking them lightly with an instrument resembling a carpet beater. In the latter case the dried berries are run through a machine resembling a fanning mill to separate them from foreign matters.

222. Insects and diseases. As several harmful parasites affect two or more of the bramble fruits, it is convenient to treat the parasites of all the species in one group.

223. The raspberry cane-borer (*Oberea bimaculata*) lays eggs in the young shoots of raspberries in early summer, causing the tips to wilt. The egg soon hatches if undisturbed, and the grub burrows downward through the pith, reaching the root in autumn. The wilted tips should be cut off below the injured part and burned. Canes of which the leaves are found wilting during late summer should also be cut out and burned.

224. The raspberry slug or saw-fly (*Selandria rubi*) sometimes devours the foliage during May and early June. It may be destroyed by spraying the foliage with water containing hellebore, or with dilute kerosene.

225. The tree cricket (*Œcanthus niveus*) lays its eggs in a rather conspicuous longitudinal row, in the canes in autumn, weakening them so that they are liable to be broken by wind (Fig. 45). The only preventive known is to cut out and burn the affected canes. These are most readily detected when the leaves are off.

226. A small fly, *Diastrophus nebulosus*, sometimes lays its eggs in canes of the blackberry causing maggots to infest the pith. The canes when thus attacked form large, dark, conspicuous, red or reddish-brown, longitudinally-

furrowed galls, which weaken the cane and destroy its functions. Such canes should be cut out and burned during autumn and early winter.

227. The anthracnose (*Glœosporium necator*) is a fungous disease that attacks the young canes of raspberries, blackberries and dewberries during the latter part of June and through July, beginning toward the base of the cane and forming circular or oval, sunken, gray spots, bordered by a distinct purple rim. In severe cases the canes crack and may be wholly destroyed. The leaves may also be more or less attacked.

Anthracnose has not as yet been fully prevented by treatment. Thorough spraying, before the buds swell in the spring, with a solution of one pound of copper sulfate in 15 gallons of water, followed by thorough applications of Bordeaux mixture at intervals of two weeks until midsummer, has been recommended. In severe attacks it is well to cut and burn all affected canes while the leaves are off.

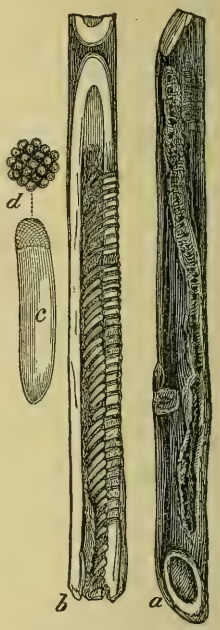

FIG. 45. Work of the tree cricket. *a*, row of punctures in cane: *b*, same cut open, showing eggs; *c*, magnified eggs. (After Riley.)

Some varieties are less subject to anthracnose than others; plantations on grounds not recently occupied by the bramble fruits often escape attack.

228. The orange rust or red rust (*Cœoma luminatum*) attacks blackberries and raspberries. Its presence is indicated by small, pale-green wrinkled leaves, followed by a copious production of orange-colored spores on the under

side of the leaves and on the stems. This disease appears to be communicated from one plant to another, especially when their roots or foliage are in contact.

All affected plants should be promptly dug out by the roots and burned.

229. The raspberry is used for dessert, canning, drying and jam, and is most important of the bramble fruits. It succeeds the strawberry in season. The native species are now grown more or less throughout the United States and southern Canada, and, with winter protection, succeed as far north as any of our cultivated fruits. The European raspberry was formerly considerably grown in the eastern states, but as its canes are less hardy than those of our native species, its culture has been nearly abandoned.

230. The blackberry, of which only one species is much cultivated, grows taller and stronger, and is commonly more fruitful than the raspberries. The oblong or cylindrical, commonly black fruit is mostly borne in leafless racemes, and ripens as the raspberries are failing. The fruit is used for the same purposes as the raspberries, but is less popular. There is a variety having bright, yellowish-green canes and short amber- or cream-colored fruit.

The blackberries fruit more extensively toward the ends of the branches than the raspberries, and hence the canes should be less cut back in spring than those of the raspberry.

231. The dewberry. The cultivated dewberries (mostly *Rubus villosus*) commonly bear larger, more juicy and earlier-maturing fruit than the blackberry. Their cultivation, while apparently on the increase, is less general than that of the raspberry and blackberry, probably owing to the expensive culture necessitated by their trailing habit (219).

SUMMARY OF THE PRECEDING SECTION

1. The "small fruits" include the cultivated berries, the currant, the dwarf cherry and the goumi (210). With the exception of the cranberry, all are packed for market in small boxes or baskets which are enclosed in crates (211).

2. The bramble fruits include the raspberry, blackberry, and dewberry (212). These are propagated either by suckers from the roots or by layering the tips of the branches. All may be propagated from root cuttings (213).

3. The bramble fruits are commonly planted 6 or 7 feet apart, in rows 7 or 8 feet apart (214). The plants begin to fruit the second season after planting; the third season they should bear a full crop (215).

4. The bramble fruits prove most continuously productive on moderately rich land (216). The plantation should be renewed once in 5 or 6 years (217).

5. The canes of the bramble fruits need more or less thinning after the second year. Three to 6 canes to a plant are sufficient. Shoots of the blackberry and blackcap raspberry are commonly pinched as they attain the height of 12 to 24 inches (218).

6. Plants of the blackberry and blackcap raspberry are often trellised to keep the canes within bounds (219). The bramble fruits may be protected in winter, in severe climates, in the manner described for the grape (220.)

7. The bramble fruits continue to improve in quality until ripe enough to drop from the plant (221).

8. The raspberry cane-borer may be destroyed by cutting off and burning the wilted tips and canes (223). The raspberry saw-fly may be destroyed by spraying with water containing hellebore or dilute kerosene (224). The tree cricket may be held in check by burning infested canes (225).

9. Anthracnose of the bramble fruits may be held in check by cutting out and burning infested canes, and planting on new ground. Spraying is but partially successful (227). The orange rust may be controlled by promptly rooting out and burning all infested plants (228).

10. The raspberry is most important of the bramble fruits (229).

SUGGESTIONS FOR LABORATORY WORK

1. Study the growth habit of the bramble fruits, ascertaining the source of the young shoots and of the fruiting branches, the natural methods of propagation of the different species, etc.

2. Practice propagating the different species by root cuttings.

3. Practice planting the young plants with the spade, in the manner illustrated for the strawberry in "Principles of Plant Culture."

4. Practice "tipping" the ends of the shoots of the blackcap raspberry for propagation.

Section 2 — The Groselles.

232. The groselles include the currants and the gooseberries. These are dwarf, many-stemmed shrubs, bearing flower buds mostly on short spurs from wood two or more years old; the young shoots grow mainly from near the base of the older ones, which are usually more or less recurved. The wood is rather soft, contains a large pith and roots freely from cuttings or layers, by which means the varieties are propagated. The groselles are very resistant to cold, and their cultural range extends over the greater part of the United States and far northward into Canada. The

following species are more or less cultivated in this country:

(a) The red (and white) currant (*Ribes rubrum*).

(b) The black currant (*Ribes nigrum*).

(c) The Crandall, Buffalo or Missouri currant (*Ribes aureum*).

(d) The American gooseberry (*Ribes oxyacanthoides*).

(e) The English gooseberry (*Ribes Grossularia*).

233. Soil and culture. While the groselles will endure neglect better than many other fruits, they respond liberally to good culture. They thrive best in a deep, rich, moist soil, and with liberal tillage or mulching.

234. Planting. The groselles are commonly grown at about the same distances as the bramble fruits. The gooseberries and the smaller-growing currants may be planted 3 by 6 feet; the larger-growing currants should not be planted nearer than 4 by 7 feet.

235. Pruning. The only pruning needed by the groselles is the cutting out of the oldest stems and the thinning of the young stems when needed. The older stems tend to droop and thus to interfere with cultivation and to bring the fruit too near the ground. Four or six young shoots are usually sufficient for one plant.

A—THE CURRANTS

236. The currants. The fruit of the currants is chiefly used for jelly and preserves. All of the cultivated species fruit chiefly on short spurs from two-year-old or older wood (Fig. 46). All are readily propagated by cuttings of the new or older wood, planted in autumn or early spring. The central buds of the cuttings are often rubbed off before planting to prevent more than two or three shoots from growing.

The currants may also be readily propagated by layering the branches, which will root the first season if covered in spring or early summer.

The red and white currant, of which there are several varieties of each color, is the only one grown commercially in America to a large extent, the black currants having not become popular in this country.

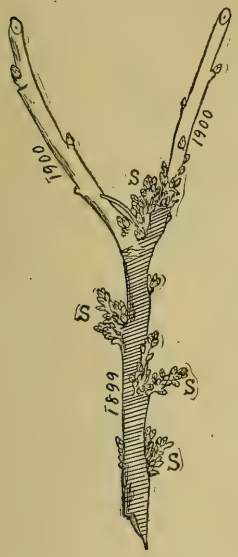

Fig. 46. Fruiting wood of red currant. S S, spurs.

The currants are so easily propagated, and fruit so young and so profusely, that the market for the fruit is readily overstocked. The crop may be left on the bushes a long time after maturity, however, which enables proportionally more of the fruit to be sold than of shorter-lived fruits.

237. Parasitic enemies. The currant, despite its hardiness, is harassed by several parasites that render the plants nearly useless unless controlled by prompt treatments.

238. The imported currant worm (*Nematus ventricosus*) attacks the foliage of the red and white currants soon after it expands in spring and usually defoliates the bushes if neglected. The eggs are commonly laid on the lower leaves near the center of the plant, and the young larvæ, which at first eat small holes through the leaves, are often unnoticed unless specially looked for. The larvæ are whitish at first, but soon become green, and later are

spotted with black, changing to green again before pupating (Fig. 47). Two or more broods appear each season.

Treatment. Spraying the affected leaves with water containing powdered white hellebore, at the rate of an

Fig. 47. Currant foliage attacked by imported currant worm. (After Saunders.)

ounce to three gallons, effectually destroys the currant worm without poisoning the fruit. The spraying should be repeated as often as the larvæ appear. An arsenite may be substituted for the first spraying if this is made immediately after the setting of the fruit.

239. The imported currant borer (*Sesia tipuliformis*) burrows in the pith of the red and white currants. The eggs are laid in the spring, usually near the buds, and the larvæ eat their way to the pith, burrowing up or down the stem, until June of the following year.

Treatment. Spraying the stems liberally, just as the leaves are expanding, with water containing Paris green will destroy many of the larvæ. Infested stems are easily detected in spring by their pale-colored foliage, which ex-

pands later than that of healthy stems. All such weak stems should be promptly cut and burned to destroy the larvæ within them.

240. The four-lined leaf-bug (*Pœcilocapsus lineatus*) attacks the leaves at the tips of the shoots during June and July, sucking out their juices. The bugs may be jarred from the bushes early in the morning, into a pan containing kerosene. The young insects may be destroyed by dilute kerosene (about ten per cent. in strength).

241. The leaf spot or rust (*Septoria Ribis*) affects all of the groselles, appearing in early summer as small, brown spots upon the foliage. In case of severe attack, the plants may become defoliated during the latter part of summer.

Treatment. To prevent this disease, the plants may be sprayed in early summer with the ammoniacal solution of copper carbonate, to be followed after the fruit is harvested with a copious spraying of Bordeaux mixture.

Plant lice (53) often attack the foliage of the groselles. On the red currant these often cause the foliage to blister and red spots sometimes form on the upper surface of the leaves. The lice are often difficult to destroy, but spraying with dilute kerosene is perhaps the most satisfactory treatment.

242. The black currant (*Ribes nigrum*) is more vigorous in habit than the red currant, and less subject to damage from insects and diseases. The foliage has a peculiar, pungent odor, and the fruit is acid and aromatic; though esteemed by some people, it is not generally popular.

243. The Crandall currant (*Ribes aureum*) is cultivated to a slight extent for its large, glossy, bluish-black, rather mild fruits, which are esteemed by some for jelly and

sauce. The best strains of this fruit are remarkably productive. The bush is the largest of the cultivated currants.

B — THE GOOSEBERRIES

244. The gooseberries are more dwarfed and more slender-stemmed than the currants, and are commonly somewhat thorny. The fruit is largely produced on wood of the preceding season, and less on spurs than in the currant. The varieties of the European gooseberry are little grown in this country, owing to their susceptibility to disease, but the native varieties are comparatively hardy and are considerably cultivated. The fruit is generally used immature for sauces, canning and preserving.

245. Propagation. The gooseberries are less readily propagated by cuttings than the currants, but are easily propagated by mound-layering. The new growth, if covered after it is several inches long, commonly roots by autumn. The shoots may then be taken up and cut apart, retaining a piece of the rooted main branch, and planted as directed for currant cuttings (236). They should form good plants by the following autumn. The slower-rooting varieties may be encouraged to root by breaking the bark slightly at the time of covering the stems.

246. Pruning. In addition to the pruning recommended for the groselles (235), the size of the fruit may be increased by cutting off one-third to one-half of the new growth just before the leaves start in spring.

247. Insects and diseases. The gooseberry is more subject to damage from the imported currant worm than the red currant, and the treatment recommended for the latter (239) should be carefully observed.

248. The gooseberry mildew (*Sphærotheca Mors-uvæ*) attacks the young foliage and fruits, causing the leaves to shrivel, and forming a cobweb-like covering over them. Later, the affected parts become whitish, as if sprinkled with a white powder. The diseased shoots often branch freely, and affected berries generally drop before maturity. The European varieties are most affected.

Treatment. This disease, being a surface fungus, is readily prevented by timely applications. The bushesm ay be sprayed early with Bordeaux mixture, but as the fruit forms, a colorless fungicide should be substituted. Weekly applications of a solution of potassium sulfide (liver of sulfur), at the rate of half an ounce to one gallon, have given excellent results. Dissolve the sulfide in a little hot (not boiling) water, adding the solution to the larger quantity of water.

Section 3 — The Strawberry

249. The strawberry is regarded as one of the most delicious of temperate fruits. As its low habit enables it to be readily protected in winter, it may be grown in colder climates than most other fruits. Its cultural range extends over all of the cultivated parts of the United States and Canada. It comes into bearing sooner after planting than any other perennial fruit plant, and since its adoption into culture it has always been popular with the amateur.

The strawberries now cultivated nearly all belong to the species *Fragaria Chiloensis*, var. *ananassa*. This species inclines to be more or less dicœcious, i. e., to produce the stamens and pistils on different plants, rather than in the same flower, hence the garden varieties, which come from seedling plants, often bear imperfect flowers.

The fruit of the strawberry is the expanded receptacle of the flower, and bears the seeds upon its surface in more or less marked depressions.

The roots of the strawberry spread laterally little farther than the leaves and commonly grow shallow in the soil, hence the plant is very liable to suffer from drought in summer.

250. Growth and fruiting habit. The strawberry commonly multiplies from trailing runners, which are slender branches proceeding from the axillary buds of the parent plant that are formed early in the season. Some of the later axillary buds do not form runners, but develop into branches of the main stem, while those formed still later, together with the terminal bud, become flower buds which live over winter and expand early the following season. The runners grow throughout the summer, rooting at the nodes, and the young plants thus formed commonly develop flower buds the same year. The following spring, the branches of the main stem above mentioned, develop leaves and runners, and later, other branches and flower buds, and thus the life of the plant is continued from year to year. The very short stem of the strawberry plant is a rhizome of the class known as caudex, which develops largely under ground and which roots at the nodes, the older roots dying as the stem elongates. It follows that the stem tends year by year to project itself above the surface of the ground. This probably limits the life of the plant, as new roots develop only from the younger nodes. The plant tends to lose vigor as it increases in age, because the roots continually become shallower in the soil, while the flower buds are more and more exposed to the weather.

251. Soil. The strawberry thrives on any soil capable of yielding good farm crops, providing it is well fertilized

and in a state of thorough cultivation. Varieties vary greatly in their adaptation to different soils.

252. Planting with reference to pollination. Since many varieties of the strawberry are more or less diœcious (250), and since many of the most valuable sorts produce little or no pollen, it is important to provide for the pollination of diœcious (imperfect-flowered) varieties by planting with them a certain proportion of one or more perfect-flowered kinds. In culture, the diœcious sorts are commonly known as *pistillates*, and the perfect-flowered sorts used to supply the pistillates with pollen are called *pollenizers*, *staminates*, or *fertilizers*. As a rule, one row of the pollen-bearing variety is planted to each 3 or 4 of the pistillate sort. Pollenizers should be selected that bloom as early as, and continue to bloom as late as, the pistillate variety with which they are grown.

253. Culture. Strawberry culture is necessarily somewhat expensive, as the low growth of the plants renders them very subject to damage from weeds. Whatever system of culture is practiced, a clean soil and frequent cultivation and weeding are essential to the highest success.

Planting. Strawberry plantations are sometimes made in late summer or during autumn, but more commonly in spring. Summer- or autumn-set plants do not make sufficient growth to form many runners or fruit-buds before winter, and hence yield but a small crop of fruit the following season. The soil about them becomes compacted during winter, hence the growth of the plants is more or less restricted the next season. Only young plants from young and healthy plantations should be used. Such plants have white roots. The plants are commonly set about 2 feet apart in rows $3\frac{1}{2}$ to 4 feet apart.

The matted-row system. Since the strawberry plant multiplies without assistance, and the young plants are formed near the parent, it is most conveniently cultivated in narrow beds (matted rows), leaving spaces 1 to 2 feet wide between the beds for cultivation and to serve as paths for gathering the fruit. As the plants rapidly lose vigor with advancing age, they are commonly permitted to renew themselves more or less completely each season. This is accomplished by removing the larger part of the plants in the matted beds after fruiting, and permitting runners from those left to refill the bed with young plants for fruiting the following year. Before this is done, the bed is often mowed over, and the cut-off material dried and burned between the rows. The spaces between the matted rows are kept well cultivated to conserve moisture and are mulched during the fruiting season to keep the fruit clean. The amount of thinning given the plants after fruiting should depend upon the vigor of the variety. The more vigorous varieties, as Warfield, on good soil, will furnish abundance of young plants if a row only 6 or 8 inches wide is left in the center of the matted bed, and if the plants in this row are fully one-half removed. The matted rows may be narrowed by turning a shallow furrow from each side, with a plow having a sharp, revolving coulter. The soil overturned may then be worked down level by a cultivator having narrow teeth. In small strawberry beds, the rows may be narrowed with the spade.

If the plantation does not suffer from lack of moisture, the young plants are likely to grow too thickly, in which case they should be thinned out late in autumn or early the following spring. As a rule, plants should not be permitted to stand less than 4 to 6 inches from each other.

The hill system. The runners of strawberry plants are sometimes removed as they form, thus causing the plants to remain single or in "hills."

Plants thus pruned form large, many-branched rhizomes, which produce more fruit than individual plants that are permitted to form runners. But the aggregate yield from plantations thus grown is usually less than from matted rows. The fruits are, however, often superior in size and quality. This method of culture is little practiced except by amateurs.

Duration of the plantation. More than two crops of fruit are seldom taken from a strawberry plantation. Many growers take but one. While the plants renew themselves, and thus make it possible to continue the plantation indefinitely, the labor required to keep out weeds is so great that it is commonly regarded wise to renew the plantation on other ground once in two or three years.

254. Winter protection is essential to the highest success in strawberry culture in climates where much freezing occurs in winter. A thin covering (one or two inches) of clean straw, marsh hay, leaves, or some other litter that is free from weed seeds should be applied before hard freezing in autumn. This covering tends to retain frost in the ground in spring, and thus retards the growth of the plants somewhat, unless promptly removed. It is often left on for a time to hold back the growth of the plants, and thus to retard the ripening of the fruit.

255. Protection from frost. The low habit of the strawberry plant renders it possible to protect the blossoms from frost to a greater degree than is practicable with the taller-growing fruits. A light covering of the litter used for winter protection, applied on the eve when frost is ex-

pected, is often successful in preventing damage from this cause.

256. Harvesting. The fruit of the strawberry is soft and perishable, hence especial care is necessary in handling it (16) (212). The fruit colors well in the package if picked slightly immature.

257. Insects and diseases. The strawberry leaf-roller (*Phoxopteris comptana*) lays its eggs upon the leaves of the strawberry in early spring. The larvæ feed upon the foliage and mature in June, causing the leaflets to roll upward, inclosing the insects. There are two broods in a season in the northern states.

Treatment. After the fruiting season, mow over the strawberry plantation, cutting off all foliage within an inch or two of the soil. When the cut-off herbage is sufficiently dry, rake it between the rows and burn it all. Should the leaf-roller be troublesome in the young plantation, spray the plants in the latter part of summer with water containing Paris green at the rate of one pound to two hundred gallons.

258. The strawberry root-borer (*Anarsia lineatella*) is sometimes very injurious to strawberry plantations. It is a reddish-pink caterpillar, nearly half an inch long, which eats irregular channels through the crown of the plant. The moth, which is the perfect form of this insect, lays its eggs on the crown of the plant, rather late in summer, and the larva burrows into the heart of the plant, where it remains during the winter, escaping early in June. For treatment see (260).

259. The strawberry crown-borer (*Tyloderma fragariæ*), a small beetle belonging to the curculio family, deposits its eggs about the crown of the plant early in summer. The

larva feeds within the crown until full grown, when it is about one-fifth inch long. It is then white, with a horny, yellow head. It transforms within the plant, the beetle escaping late in summer. Infested plants soon perish. Old beds are more liable to attack than young ones. For treatment see (260).

260. The may beetle. The larva of this insect (*Lachnosterna fusca*), commonly known as the white grub, often attacks the roots of strawberry plants late in summer, especially when the plantation was made upon inverted-sod ground, and sometimes proves very destructive.

Treatment. The only known way of combating the strawberry root-borer, crown-borer and white grub is to dig out all infested plants and destroy the larvæ within or about them.

261. The strawberry saw-fly (*Emphitus maculatus*) is sometimes very destructive, in its larval stage, to the leaves of the strawberry. The eggs are laid in the stem of the leaf early in May, and the larvæ feed upon the leaves until mature, when they are pale green, with a faint, whitish bloom, and nearly three-fourths of an inch long.

Treatment. The foliage may be sprayed, before the fruit matures, with water containing hellebore powder at the rate of an ounce to three gallons. Cutting and burning the foliage, as recommended for the leaf-roller (258), will destroy many of the larvæ.

262. Thrips. A minute insect (*Euthrips tritici*) sometimes destroys blossoms of the strawberry by feeding on the stamens and pistils. No preventive for it is known.

263. The strawberry leaf-blight, also called *rust* and *sunburn* (*Sphærella Fragariæ*), attacks the foliage of strawberries during the growing season, often becoming serious

late in summer and during autumn — especially on plantations more than one year old. The first symptom is the formation of small, purple spots, which increase in size to an eighth or a quarter of an inch in diameter. The purple color soon changes to clear, reddish-brown, which becomes still lighter as the season advances. The edges of the spots, however, generally remain purple. The fungus passes the winter by a mycelium contained within the leaves, as well as by spores.

Treatment. Burning the foliage after the fruiting season, as recommended for the strawberry leaf-roller (257), generally prevents serious damage from this disease.

264. The strawberry mildew (*Sphærotheca castagnei*) attacks both the berries and the leaves, covering them with a thin net of mycelium resembling delicate cobwebs. The affected leaves fold up on the midrib and appear as if suffering from want of water. The disease is thought to be most serious on poorly-drained ground.

Treatment. Sprinkle flowers of sulfur upon the foliage and between the plants as soon as the symptoms appear; or spray unfruiting plants with Bordeaux mixture.

SUMMARY OF THE TWO PRECEDING SECTIONS

1. The groselles include the currants and gooseberries. While these are very hardy shrubs, they respond liberally to good treatment, and thrive best in a deep, rich, moist soil, with thorough tillage or mulching (232, 233).

2. The groselles may be planted at the same distances as the bramble fruits (234). They are pruned by thinning out the older branches (235).

3. The currants are chiefly used for jelly and preserves. They are propagated from cuttings, which may be planted

in the open ground. The market for currants is easily overstocked (236).

4. The imported currant worm is readily controlled by spraying with water containing hellebore powder in suspension (238). The currant borer may be held in check by spraying the stems with water containing Paris green, and by cutting and burning infested stems (239).

5. The leaf spot of the groselles may be prevented by timely sprayings with ammoniacal copper carbonate or Bordeaux mixture (242).

6. The fruit of the gooseberry is generally used immature, for sauces, canning and preserving (244).

7. The gooseberry is commonly propagated by mound layering (245).

8. The gooseberry mildew may be prevented by spraying with Bordeaux mixture or a solution of potassium sulfide (248).

9. The strawberry plant comes sooner into bearing and is cultivated over a wider range than most other fruit plants (249).

10. The strawberry plant multiplies itself from runners which root at the nodes. The stem tends, year by year, to project itself above the ground, making the roots shallower in the soil and exposing the flower-buds more to the weather (250).

11. The flowers of many varieties of the strawberry bear little or no pollen; such varieties are fruitful only when grown near others that yield abundant pollen (252).

12. The strawberry is commonly cultivated in narrow beds (matted rows). The plants are mostly renewed each season by narrowing the matted rows after fruiting. The spaces between the rows should be well cultivated, except

during the fruiting season, when they are commonly mulched. New plantations are usually made in spring (253).

13. Winter protection is essential to the highest success in strawberry culture, where much freezing occurs in winter (254). Protection from frost during the growing season may be given by covering the plants with litter (255).

14. The strawberry leaf-roller and the strawberry leaf-blight may be held in check by mowing over the plantation after the fruiting season and burning the cut-off foliage (257–263). The root-borer, the crown-borer and the may beetle are combated by digging out infested plants and destroying the larvæ (258–260).

15. The strawberry saw-fly may be destroyed by spraying the foliage with water containing hellebore powder (261). The strawberry mildew may be held in check by sprinkling flowers of sulfur upon the foliage and between the plants, or by spraying with Bordeaux mixture (264).

SUGGESTIONS FOR LABORATORY WORK

1. Practice propagating the currant by layers and cuttings, and the gooseberry by mound-layering.

2. Study the stems of the currant and gooseberry while in flower or while bearing fruit, to ascertain the fruiting parts.

3. Study the insects and diseases affecting the currant and gooseberry from the growing plants, and apply the remedies therefor.

4. Study the characteristics of different species and varieties of the currant and gooseberry from living plants.

5. Study the morphology of the strawberry plant by washing out and examining plants of different ages.

6. Study in the plantation the insects and diseases affecting the strawberry plant.

7. Practice picking and packing the fruit of the strawberry.

Section 4—The Cranberry

265. The cranberry differs from other temperate fruit plants in being partially aquatic in habit. In its wild state it thrives best in peat marshes so located that they are submerged during the freezing part of the year, and in which the water level lowers to a foot or two below the soil surface during the warm season. If the water contains lime in solution, the plants are rarely permanently productive. In culture, the cranberry can only be grown successfully when its environment is very similar to that which surrounds the productive wild marshes.

But one species of the cranberry has been cultivated to any large extent, viz., the large or American cranberry (*Vaccinium macrocarpon*). This species is native from Virginia northward, and westward to Wisconsin. The plant is creeping, with slender, scarcely-woody stems bearing small evergreen leaves.

266. Fruiting habit. The flowers are borne on slender shoots that grow from wood of the preceding year. The flower-buds form in autumn, mostly in the terminal buds of these shoots, but the latter grow on the next season, so that the flowers become axillary as in the grape. The fruit ripens in autumn, and, in some varieties, keeps until spring.

267. Cultural range. The cranberry is chiefly cultivated in Northern United States and Canada, and since its

successful culture is limited to soft-water marshes, it can hardly become extensively grown as compared with our other cultivated fruits. It is at present most grown on the peninsula of Cape Cod, in parts of New Jersey, Maine and Wisconsin, and in Nova Scotia.

268. Culture. The highest success in cranberry culture requires not only the proper soil with abundance of soft water, but the power to control the water supply at all seasons of the year. The ability to drain the plantation during the growing season so that the water level is a few inches below the surface of the soil is, however, of greater importance than the power to flood it at will.

The culture of cranberries is carried on under two methods, viz., on improved wild marshes and on artificially planted ones.

269. Improving wild marshes. This consists chiefly in clearing the ground that already produces wild cranberries, of trees, logs, bushes and other rubbish, in draining it more or less thoroughly, and in providing certain facilities for controlling the water. The draining should be performed gradually. It is cranberry culture in its simplest form, and the improvements are carried to a greater or less extent according as the work proves profitable. The fruit produced on wild marshes is rarely uniform as to size or keeping quality, and hence is not usually as valuable as that produced on the better planted marshes.

270. Selecting ground for the cranberry. Grounds suitable to cranberry culture are generally subject to frost, and hence should be selected with especial reference to cold-air drainage.

Only alluvial or mucky soils that are free from clay or loam are adapted to the cranberry. An equal mixture of

coarse sand and muck, or a layer of pure muck, with coarse sand above or below, is the ideal soil. Pure muck produces an excessively rampant growth that is not fruitful. In New Jersey and Massachusetts, the muck is commonly covered with a layer of coarse sand.

The cranberry requires moisture always near the surface, but this water must not be stagnant. On true cranberry ground, the soil rarely becomes dry more than half an inch below the surface.

271. Preparing the marsh for planting. Drainage first requires attention. A main ditch is commonly cut about two feet below the surface of the muck layer, wide enough to contain so much of the marsh water that the surface will not be flooded after heavy rains. The bushes are next piled into heaps in a dry time and burned, and it is well if the turf also burns. The remaining turf is next cut into blocks and removed. These blocks of turf are sometimes used for fencing the marsh or for making dams. The stumps are then cut off even with the surface of the muck, and a sufficient number of branch drains cut through the marsh to drain the whole to the depth of 12 to 18 inches. The earth removed from the branch drains is commonly spread over the surface. Where sanding is practiced, a layer of sand is next put on, of a thickness proportional to the depth of the muck. When the latter is 1 to 2 feet thick, the sand layer should be 2 to 3 inches thick.

272. Planting. The cranberry is propagated from cuttings of the young wood, which are planted in place. These should be taken from plants that produce freely of large, well-colored and good-keeping fruit. To procure the cuttings rapidly, the vines from a well-matted marsh are often mown off close to the ground with a scythe, and,

after picking out the coarser stems, the parts suitable for cuttings are cut into pieces 1 to 6 inches long. Sometimes the stems are run through a feed cutter. The cuttings may be planted in spring or early summer and in autumn. They are sometimes planted in drills opened with the plow, 1½ to 3 feet apart, but often they are sown evenly over the prepared surface of the marsh, which is preferably covered with about an inch of water. Sometimes the cuttings are pressed into the moist soil, but where the water layer can be maintained, this is not necessary.

273. **Care after planting.** Grass and weeds should be kept out of the marsh until the vines are well matted. A moist surface should be maintained, but ground water should be kept 12 or 18 inches below the surface. Scattering vines are sometimes benefited by rolling the marsh. Old vines may often be restored to vigor by mowing them off in spring, though the first one or two crops thereafter will be diminished. The plantation needs little attention during the growing season, except to look after the water supply and insect attacks.

274. **Flooding at certain times** is necessary to insure permanence to the vines, and to protect from insects and frost. It is accomplished by damming up the water, causing it to rise in the ditches, and suitable dams should be provided for this purpose. Bearing plantations should be flooded when growth ceases in autumn, and should be kept covered with water until the following spring is so well advanced that danger from frost is no longer feared. Occasionally the plants are flooded during the growing season, to destroy insects or prevent frost. Many cranberry marshes have no facilities for flooding, but on such the crop is quite uncertain.

275. Picking and storing. The berries are ripe enough to gather when the seeds are brown. Picking should commence as soon as the fruit is well colored, and the fruit should be so handled as to prevent bruising. It should only be picked when dry, or if necessarily gathered wet should be quickly dried. The later berries that are not well colored when picked will improve in color if spread in a shaded, airy place.

Many cranberries are now gathered with an implement resembling a rake, the use of which is thought to benefit old and densely-matted vines, by thinning them out. Berries so gathered are run through a machine resembling a fanning mill, to free them from foreign matters.

Different varieties of the cranberry vary greatly in keeping quality, hence the early and later varieties should not be mixed, if the fruit is expected to keep well. Berries free from spots and bruises, and of a good keeping sort, should keep all winter in a cool cellar. They may be preserved indefinitely by canning, and by placing them in stone jugs or crocks, filling the latter with cold water that has been previously well boiled, and storing in a cool cellar, they are said to keep a full year, or even longer.

Cranberries keep best in boxes sufficiently open to permit ventilation. They are commonly packed for market in barrels.

276. The black-headed cranberry worm (*Rhopobota vacciniana*) (the "vine worm" of Massachusetts and the "fire worm" of New Jersey), and the *yellow-headed cranberry worm* (*Teras vacciniivorana*) feed on the foliage, buds and young berries during summer, often proving very destructive. They are held in check by retaining the water on the marshes late in the spring, or by drawing it off early

and then reflowing after the eggs have hatched. The larvæ and eggs may also be destroyed by spraying with kerosene emulsion.

277. The fruit worm (*Acrobasis vaccini*) (Fig. 48) is often very destructive. The moth appears at the time the berries are beginning to form, and deposits eggs, usually in the calyx. The larvæ feed on the fruit until September. Spraying the plantation as soon as the berries are set, with water containing Paris green at the rate of a pound to 200 gallons, is thought to destroy the larvæ as they attempt to enter the fruit. Lighted lamps, set at night over vessels of water distributed about the marsh, are said to destroy many of the moths.

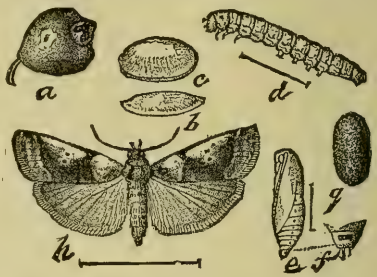

FIG. 48. Cranberry fruit worm. a, berry, showing egg; b, egg from side; c, egg from top; d, larva; e, pupa; f, tip of pupa; g, cocoon; h, perfect insect. All enlarged; lines indicate natural size. (After Riley.)

278. Other harmful insects. *The tip worm* (*Cecidomyia vaccinii*) sometimes destroys the terminal buds, and *a scale insect* (*Aspidiotus* sp.) which occasionally infests the stems, may probably be held in check by kerosene emulsion. *Grasshoppers* and *locusts* are sometimes troublesome, and may be controlled in a measure by keeping turkeys on the marshes.

Section 5 — The Miscellaneous Small Fruits

279. The species. These include:

(a) The dwarf cherry (*Prunus Besseyii*).

(b) The dwarf juneberry (*Amelanchier Canadensis*, var. *oblongifolia*).

(c) The buffalo berry (*Shepherdia argentea*).
(d) The goumi (*Eleagnus longipes*).
(e) The huckleberry (*Gaylussacia*).
(f) The blueberry (*Vaccinium*).

With the exception of the goumi, these are all native shrubs. None of them are as yet extensively cultivated, and they are of interest chiefly for their possibilities of improvement. With the exception of the last two species, seedlings of these fruits may be grown as directed for the plum (104), and the culture they require is similar to that of the groselles (233–235). All are hardy throughout the United States and Southern Canada, except the goumi.

280. The dwarf cherry. Several species of dwarf cherry are native to the United States, but the only one cultivated to any extent is the so-called dwarf Rocky Mountain cherry, (*Prunus Besseyii*). This is a rather spreading, few-stemmed shrub, commonly growing about four feet high. The fruit, which is somewhat heart-shaped, is about three-fourths inch in longest diameter. It is black when ripe, slightly sweet, sometimes a little astringent, and ripens in August and September. The plants are very fruitful, and are ornamental while in flower, and also late in autumn, when the willow-like leaves assume a rich scarlet color. The plant is decidedly variable under culture.

281. Harmful parasites. The dwarf cherry is subject to several fungous diseases. A mildew (*Podosphæra oxycanthæ*) attacks the foliage in summer, giving it a whitish appearance. Spraying the plants with Bordeaux mixture, or potassium sulfide solution, would doubtless prevent it. A disease similar to the leaf curl of the peach (123) also attacks this plant, and the fruit-rot fungus (101) sometimes causes many of the fruits to decay as they are ripening.

282. The dwarf juneberry. This fruit is allied botanically to the apple. It is extremely variable in the wild state, and some of its varieties attain the size of a large tree. The form that has been most cultivated (variety *oblongifolia*) is a spreading shrub that commonly grows about three feet high. The fruit resembles that of the huckleberry in form and size, but is reddish-purple in color. It ripens in June and July, is white-fleshed, and has a pleasant but not strongly-marked flavor. Birds are extremely fond of the fruit, which is one of the most serious obstacles to its culture.

283. The buffalo-berry. This shrub grows 3 to 6 feet high, bears narrow, silvery leaves, small, dicœcious flowers, and scarlet, acid fruit about the size of huckleberries, ripening late in summer. It is little cultivated.

284. The goumi is a low shrub, with grayish-green leaves, inconspicuous flowers and small, scarlet, gold-speckled fruit that ripens before midsummer. The fruit is too acid and astringent for use in its fresh state, but is prized by some for preserves. The plant is not sufficiently hardy for northern United States unless protected. Its seedlings are quite delicate, and hence are rather difficult to grow to bearing size.

285. The huckleberry and blueberry. The fruit of several species of the huckleberry and blueberry is rather extensively gathered from wild plants in parts of northern United States and southern Canada. These fruits do not seem adapted to ordinary methods of culture, but they may prove amenable to a system resembling that employed for the cranberry. Their intrinsic qualities certainly commend them for market fruits.

SUMMARY OF THE TWO PRECEDING SECTIONS

1. The cranberry is partially aquatic in habit. It thrives in peat marshes that are submerged in winter, and in which the water is a foot or two below the soil surface during the warm season (265).

2. The cranberry is chiefly cultivated in soft-water marshes, and in northern United States and Canada (267).

3. The highest success in cranberry culture requires the proper soil and abundance of soft water, with ability to control the water supply at all seasons of the year (268).

4. Wild cranberry marshes are sometimes improved without replanting. The ground is cleared of logs, bushes, etc., and provision is made for controlling the water. The fruit produced on such marshes is generally inferior in quality (269).

5. Ground for the cranberry should be selected with reference to air drainage. Only alluvial or mucky soils, free from clay or loam, are adapted. A mixture of coarse sand and muck, or a layer of muck with coarse sand above or below, is best. The water must not be stagnant (270).

6. In preparing the marsh for planting, a main ditch is dug, about two feet below the surface of the muck layer, wide enough to hold the marsh water. The turf is next removed, and branch drains are cut through the muck. A layer of sand is then often applied (271).

7. The cranberry is propagated from cuttings of the young wood, planted in place, or, where the marsh is covered with water, the cuttings may be sown broadcast, without other planting (272).

8. The cranberry marsh needs little attention during the growing season except to control the water supply and destroy harmful insects (273).

9. Flooding the cranberry marsh at certain times is necessary to maintain health of the vines and prevent frost and insect attacks. Bearing plantations should be under water from the close of growth in autumn until after the frost season in spring (274).

10. Picking the cranberry should commence when the fruit is well colored. Fruit of early and later varieties should not be mixed. Cranberries keep best in somewhat open boxes (275).

11. The black-headed and yellow-headed cranberry worms are held in check by controlling the water or by spraying with kerosene emulsion (276).

12. The fruit worm is combated by spraying with water containing Paris green or by setting lighted lamps over vessels of water at night (277).

SUGGESTIONS FOR LABORATORY WORK

1. If a cranberry marsh is sufficiently near, have the students visit it and study the methods of culture, including the system of water supply, and the characteristics of the plants.

2. Study as many of the miscellaneous small fruits named in section 5 as can be found in the vicinity, and make such experiments in their culture as the season permits.

CHAPTER V

THE STORAGE AND PRESERVATION OF FRUIT

Section 1—The Storage of Fruit

286. Definition and aim of storage. More or less time generally intervenes between the gathering of fruit and its departure to the market or transportation company. This interval may vary in length from a few minutes to several months. The fruit, meanwhile, must be well cared for or it will deteriorate more or less rapidly. *Storage*, to the commercial fruit grower, means the care of the fruit during this interval. The storage of fresh fruit is a more complicated problem than the storage of ordinary merchandise, because fresh fruit tends constantly to undergo changes in the direction of decay. The aim of storage is generally to hold these changes in check, so far as possible. A knowledge of the conditions affecting these changes is, therefore, necessary to the proper management of fruit in storage.

287. The maturity of fruits, i. e., the changes in their texture and flavor that render them pleasing and wholesome as food, is a step in the direction of decomposition. These changes increase in activity, within certain limits, as the temperature rises. During these changes most fruits give off water rapidly, hence, when confined in packages, the air between the fruits tends to become saturated with water. Normal fruit does not usually decay until the last stage of maturity is reached.

288. Conditions affecting decay in fruits. The juices of fruits furnish most favorable conditions for the rapid development and multiplication of bacteria. The unbroken

skin of fruits, however, tends to prevent the access of bacteria or their spores to the juices beneath. It follows that the least breakage of the skin of a fruit invites rapid decay. Moisture on the skin of a fruit favors the germination of the spores of bacteria, and hence promotes decay. A moist atmosphere is probably not, in itself, detrimental to the keeping of fruit, but it endangers dampening of the skin. A low temperature retards decay because it retards both the ripening of fruit and the multiplication of bacteria.

289. How to promote the keeping of fruit. From the three preceding paragraphs it is evident that the keeping of fruit is promoted, (a) by gathering the fruit before it is fully mature, (b) by avoiding breakage of the skin, (c) by gathering the fruit when it is dry and keeping it dry, and (d) by placing it in a temperature low enough to retard its maturity and the development of bacteria.

290. Fruit may become moist in storage. When a package of warm fruit is placed in a cool apartment the air between the fruits in the package may become so far saturated with moisture before the fruit cools to the temperature of the room, that a part of its moisture will be condensed upon the skin of the fruit. This must happen if the temperature of the apartment is as low as the dew point of the air in the package. The warmer the fruit is, and the cooler the apartment, the greater is the danger of the fruit becoming damp. Fruit thus dampened is slow to become dry, unless it is removed from the package. Wrapping the fruits individually in absorbent paper tends to prevent the injurious condensation of water.

To prevent fruit from becoming moist in the package, it is probably best to carry it as fast as gathered to a cool, dry room, and expose it to the air, in the vessels in which

it was picked, until it becomes as cool as the room. The cool temperature will check the passing off of moisture from the fruit, and the dry air of the room will absorb the moisture as it is given off. Dryness of the air in this room may be promoted, if need be, by exposing baskets of unslacked lime. When the fruit has become as cool as the room, it may be packed in dry packages, and the packed fruit may remain in the room until it is desired to remove it. If to be kept some time, it would better be removed to a second room in which the air is less dry than in the first apartment.

291. Fruit may become moist when removed from storage. When a loose package of cold fruit is brought from the storage room into a warmer atmosphere, moisture will be condensed upon the fruit and the package whenever the temperature of the latter is lower than the dew point of the atmosphere. The fruit thus becomes damp and warm at the same time, which tends to rapid decay. If the package is tight, however, this will not occur, because the air between the fruits in the package, as it becomes warm, will tend to absorb moisture from the fruit, while the moisture from the external air will be condensed on the outside of the package.

To prevent fruit from becoming damp when removed from cold storage, therefore, it is only necessary to wrap the package in impervious cloth until the package and its contents become as warm as the external air. This precaution is, however, seldom taken.

292. The kind of storage used by the fruit grower will of course depend much upon circumstances. As a rule, only those fruit growers who are located near a city of sufficient size to support a commercial cold-storage house will

be able to use artificial refrigeration. Those so located may often store their fruit for a time with profit, since the storage rates are generally reasonable. Forty cents per barrel is commonly charged for storing apples from autumn until May 1st, and it seldom happens that fruit does not advance in price more than that by March 1st, while a rise of $1 or even $1.50 per barrel is not infrequent. Sometimes an arrangement can be made by which the grower can take out and sell portions of his fruit from time to time, thus dispensing with the services of the middleman.

293. Only sound fruit will repay cold storage. Only fruit that is free from blemishes and somewhat hard when packed can be depended upon to keep in cold storage. The folly of investing storage charges in bruised, soft, and insect-eaten fruit has been demonstrated by many trials.

294. Co-operative storage houses in fruit-growing districts have been suggested, but they are likely to prove satisfactory only when the amount of fruit available is sufficiently large to warrant a modern refrigerating equipment and the services of a competent manager (19). The large, city storage-house has advantages due to its location. Fruit can be delivered therefrom to purchasers in all kinds of weather, and if on the seaboard, it may be withdrawn for shipment at any time. On the other hand, fruit necessarily taken from the tree in warm weather can be placed in the co-operative storage-house much sooner than in the city storage-house. A co-operative storage-house in the country may sometimes be combined with a creamery storage-house, to the advantage of all concerned.

Section 2 — The Preservation of Fruits

295. The preservation of fruit, as here used, means the submitting of fresh fruit to some process by which decay

is prevented. While the preservation of fruit has no necessary connection with its production, the fruit grower often finds it convenient to employ preservative methods for a portion of his products. As competition in fruit growing increases, the market demand for the poorer grades of fruit is sure to diminish. A certain amount of poor fruit is inevitable, where fruits are grown at all, and at certain times the market cannot use all the good fruit that is offered. To avoid loss, at such times, the grower may be obliged to practice some method of preserving a part of his fruits. A few hints upon the preservation of fruits are therefore given.

296. The methods of preserving fruits may be referred to five, viz:

(a) Expelling a sufficient portion of water from the fruit (*drying or evaporating*), so that the bacteria of putrefaction are unable to live upon it.

(b) Boiling the fruit in sealed vessels (*canning*), which destroys the spores of bacteria already in contact with the fruit, and shuts out all others.

(c) Replacing the juice of the fruit with sugar syrup (*crystallization*), which renders the pulp of the fruit uncongenial to bacteria or their spores.

(d) Boiling the fruit with sugar until the juices are sufficiently concentrated to retard or prevent decay, as in jams, marmalades and fruit butters.

(e) Treating the expressed juice of the fruit to preservative methods, as in jelly or unfermented grape juice, or permitting it to ferment to a greater or less extent, as in cider, wine, vinegar, etc.

All these methods of preserving fruits have become important industries in certain sections. In this connection

it is only practicable to state the principles that control the different processes. The beginner can hardly master any of the methods without experienced aid, but it is important that the fruit grower should know the available means for preserving his fruits, and sufficient of the principles governing them to enable him to form an intelligent estimate of the apparatus needed for the different processes.

297. Preserving fruits by drying. In warm countries having a comparatively dry atmosphere, fruit is largely dried by direct exposure to solar heat, and, with proper care, excellent results are secured by this method. The fruit is placed upon tight-bottomed trays made of thin lumber, and these are placed on the ground or upon low stagings, in a location free as possible from dust. The fruit is protected from rains and dews by piling the trays one upon another, or by covering with cloth or paper. Sometimes heavy paper is substituted for wood for the bottom of the trays, or sheets of heavy oiled paper are used instead of trays.

In cool climates, the best quality of dried fruit can only be secured by the use of artificial heat (evaporation).

298. Fruit evaporation is a process now extensively used for drying fruit. The fruit is spread upon trays having a slatted or sieve-like bottom, and is exposed to a current of hot air, generated either directly by a furnace, or indirectly by a system of steam pipes. The trays are usually arranged one above another, in a vertical or inclined shaft provided with an elevating apparatus by which the trays may be raised through the shaft at intervals. The trays containing the fresh fruit are inserted at the lower end of the shaft, directly over the heat generator, and as each new tray is

slipped in, all previously inserted are elevated a short distance. By the time the shaft is filled to the top with the trays of fruit, those first put in are sufficiently dry to remove.

Trays made of galvanized iron are objectionable owing to the liability of the zinc to become detached and mingled with the fruit. Those made wholly of wood, or with the bottom of non-metallic netting, obviate this objection while adding the one of combustibility.

Fruit evaporators are now made of various styles, though differing chiefly in minor details, and of sizes varying from the cook-stove evaporator, intended to dry but a bushel or two of fruit per day, to mammoth machines drying hundreds of bushels in the same time. Apples, peaches and raspberries are chiefly evaporated in the east; prunes, plums and apricots are extensively evaporated in the Pacific states. The finer grades of the larger fruits are evaporated only when prices are very low. The smaller evaporators can be operated with profit only where labor is very cheap.

The superiority of evaporated over sun-dried fruits is now generally recognized in the markets of the world.

Sulfuring the whiter-fleshed fruits, to prevent discoloration of the cut surfaces, is largely practiced both in sun-drying and evaporating fruits. The fruit, after having been prepared for drying, is treated for a short time to the fumes of burning sulfur. This prevents discoloration, and in a measure restores the whiteness of parts already discolored. It is usually performed in a sort of cabinet without bottom, made of matched lumber, with openings for dampers at the top and below, and with a door which includes the whole of one side. The cabinet should be of a length corresponding to the length of the trays, and of a

width a little more than that of the trays. Into this cabinet, the trays slide on cleats, as drawers slide into a bureau. Each alternate tray is pushed clear in, thus leaving a little space next to the door, and the others are pushed in only far enough to permit the door to close. This makes a zigzag flue for the sulfur fumes, which pass alternately back and forth between the trays. The sulfur may be burned in a pit in the ground beneath the cabinet, or in a little furnace outside, the fumes being conducted in through a pipe. The dampers mentioned above should be opened until the cabinet becomes filled with the fumes, and then tightly closed. A convenient method of handling the sulfur is to dip strips of cheese cloth or other cheap cotton fabric in the melted substance for a moment, and, when these are cool, the desired amount may be torn off, lighted, and placed in the pit or furnace. The length of exposure depends on the kind and condition of the fruit and must be learned by experience. It should not be longer than is necessary. Thirty minutes may suffice, or sixty may be required.

The sulfuring of fruit has often been condemned on sanitary grounds, but is not likely to be abandoned so long as purchasers prefer the sulfured article. Sulfuring before drying, and only sufficient to secure bleaching, does not render the fruit unwholesome, though it does detract somewhat from its natural flavor. Sulfuring after drying may, however, render the fruit positively unwholesome. Sulfured fruit does not readily absorb water, and, unless first soaked for several hours in cool water, does not swell up to its normal bulk in cooking, and is comparatively tough and indigestible when cooked.

Prunes are often dipped in a weak boiling lye (one

pound concentrated lye to 20 gallons of water), or passed through a "pricking" machine before drying to break the skin in many places. These treatments hasten the drying and improve the appearance and flavor of the dried product.

The amount of drying required differs with different fruits, and must be learned largely by experience. It is neither necessary nor desirable that all of the water should be driven off. The color and feeling of the fruit guides the expert. When sufficiently dry, the fruit is removed from the trays, assorted and sifted, if need be, to remove dust, etc., when it is placed in boxes or piles for *sweating*, during which the remaining moisture equalizes through the mass. The fruit should be turned occasionally to facilitate this process. If packed before sweating, injury may result. The fruit is often dipped for a moment in boiling water or highly heated a few moments in a close chamber before the final packing, to destroy insect eggs and render it pliable, after which it is covered in a dark room for twenty-four hours. Prunes are commonly *glossed* by dipping them, after drying, in hot water containing pure glycerine at the rate of one pound to 20 gallons; sometimes they are exposed to steam heat, as a substitute for the hot water.

299. Packing dried fruits. Dried fruit is commonly packed in wood boxes, which are often lined with thin paper, and the larger fruits, especially all that are cut into sections in preparation, are *faced* in the package, i. e., the first fruits or sections put into the box are placed in regular rows, which often overlap one another like the shingles on a roof. Sections of the stone fruits, as the peach and apricot, are usually placed with the stone side down.

Sometimes the sections are first flattened out by running them through a clothes wringer or a similar pair of rollers. After a layer is thus formed over the bottom, a frame of the proper dimensions is placed upon the box, to temporarily increase its depth, when the amount of fruit the box is to contain is poured in, and pressure is applied until the bottom can be nailed on. The box is then inverted and branded or labeled on the faced side.

Dried fruit is also sometimes packed in cotton sacks. These cost less than boxes, which is perhaps the only argument in their favor.

300. Preserving fruits by canning. Fruit for canning should be of good quality and well ripened. It may be placed in the can either before or after boiling. In the former case the greater part of the boiling is performed before sealing, enough being given after sealing to insure the destruction of any spores that may have entered during the sealing process. In the latter case, the cans, having been first treated to boiling water to destroy any adhering spores, are filled with the boiling-hot fruit, and sealed at once.

Canned fruit can only spoil from imperfect sealing, from boiling an insufficient time to destroy all spores of bacteria, or from insufficient exposure to heat after sealing. Sugar or syrup is not essential to the keeping of canned fruit. In point of economy, the sweetening might wisely be deferred until the time of serving, since a part of the sugar is changed to glucose if cooked with the fruit. This detracts from its sweetening power. Many prefer, however, to add the sugar or syrup wholly or in part before cooking, as the flavor of the product is thereby improved.

Alum is sometimes used in canning fruit to prevent

breaking down of the pulp — a practice to be emphatically condemned on sanitary grounds.

Fresh cider and grape juice are often preserved by the canning method, either in cans or bottles. Thus prepared they are refreshing and wholesome drinks. Bottled fresh grape juice is now a commercial product of considerable importance.

301. Preserving fruits by crystallization. In this process the syrup with which the pulp of the fruit is filled prevents the development of bacteria, and thus preserves the fruit without destroying its form or consistency. The well-ripened fruit is immersed in boiling water long enough to extract the juice without softening the pulp, after which it is covered in earthen pans with a syrup of white sugar, of which the density is varied to suit the firmness of the fruit, until fermentation reaches a certain stage — usually about a week. The fruit and syrup are then heated to boiling, which checks the fermentation, and the fruit is left in the syrup for about six weeks, the mass being reheated as often as necessary to stay fermentation. The fruit is then removed from the syrup, washed in clean water, dipped again in a thick sugar syrup and exposed to the air until the syrup hardens, after which it is ready for packing, and will keep well in any climate. Crystallized fruits are often called "candied" fruits.

302. Fruit jams or marmalades are made by boiling the fruit in water until thoroughly tender, pressing the pulp through a colander, then adding sugar in quantity depending upon the fruit, and again boiling until the desired concentration is reached. Jams are made from the smaller and more tender fruits, as berries, and marmalades from the larger and firmer fruits, as the apple, quince, orange, etc.

Fruit butters resemble marmalades, except that spices are often added. In apple butter, the fruit is stewed in boiled cider.

303. Jellies differ from jams and marmalades in being formed from the *juice* of the fruit instead of the *pulp*, and hence may be made from imperfect fruit, or from the skins and cores. The jellies of commerce are too often grossly adulterated.

Jams, marmalades and jellies, being made rich with sugar, keep a considerable time if excluded from the air and stored in a cool place. They may be kept indefinitely by canning. Special appliances for their manufacture on a large scale are on the market.

304. Cider is the expressed juice of the apple, either fresh or partially fermented. Fresh cider soon undergoes fermentation unless submitted to preservative methods, at first developing a small percentage of alcohol (vinous fermentation) which later changes to acetic acid (vinegar). Cider is used as a beverage and, after boiling to the consistency of thin syrup, for fruit sauces, mince pies, etc. It may also be made into jelly (303).

305. Apples suitable for cider. The quality of cider, either for drinking or vinegar, depends much upon the proportion of saccharine matters it contains, and this depends in a measure upon the ripeness of the apples used. As a rule, the better the apple the better the cider, but some crabs and russets, that are little prized for dessert, make the best of cider. Sweet apples are not always superior to sub-acid ones for cider; watery and flavorless apples are poorest.

306. Care of cider apples. Apples intended for cider are preferably stored in a dry, airy place, where they will tend to ripen, and their juices will tend to evaporate. Flavors

absorbed by apples are likely to be retained in the cider, hence apples intended for cider should not be in contact with the soil nor with any musty or unclean material. If soiled when gathered, they should be washed, and all decaying fruits should be rejected.

307. Manufacture of cider. The apples are reduced to pulp in a mill made expressly for the purpose, and the juice is expressed from the pulp (pomace) by means of heavy screws or levers. Mills and presses are now on the market of capacities varying from the smallest farm mill, operated by hand and producing a single barrel of cider per day, to the large power mill that turns out hundreds of barrels in the same time. The hand mills are generally combined with small presses. They are not economical, as their operation requires much labor, and their presses extract less of the cider than do the larger presses.

The pulping machines are of two general classes. In one, the fruit is crushed into pulp; in the other it is scraped or grated into pulp. Certain French experiments indicate that machines of the latter class yield the larger percentage of cider. The best machines are said to extract but about 60 per cent. of the juice of apples. For pressing, the pulp is built up into a "cheese" formed of thin layers, separated by layers of straw, or in the more modern mills, the layers of pulp are wrapped individually in coarse cloth and separated by wood racks. After pressing, the cheese is sometimes taken down and rebuilt, adding water freely to the pomace, and pressed a second time, the product of the second pressing being used for vinegar or jelly. Finally, the apple seeds may be washed out of the pomace for sale, and the residue applied to the compost heap. Sometimes the pomace is broken up into small pieces and planted for the production of apple seedlings.

308. Filtration of cider. Cider to be used for drinking should be *filtered* to remove particles of pulp, skin, seeds, etc., which give it a more or less turbid appearance, and hasten fermentation. Large filters, for the rapid filtration of cider, are on the market. Those in which the cider passes through sand or clay are generally objectionable, as they tend to impart an earthy flavor.

A filter for a small amount of cider may be made as follows: bore a half-inch hole through the bottom of a wood pail, and into this insert a short wood tube, projecting downward. Then spread over the bottom of the pail, inside, circular pieces of clean-washed and dried cotton wadding, cut to fit the pail, until, when pressed down, they cover the bottom of the pail to the depth of 3 or 4 inches. Cover the wadding with 2 or 3 inches of clean quartz pebbles about the size of a pigeon's egg, to keep it closely pressed. When clogged by use, the top layer of wadding can be replaced by a new one, or all of the wadding can be washed. Cider to be filtered should first be strained through a very fine strainer.

309. Cider vinegar. Dilute alcohol containing the vinegar ferment (*Mycoderma aceti*), exposed to the air at a suitable temperature, changes to acetic acid (vinegar), hence cider, after developing alcohol, tends to become vinegar. The more thorough the exposure of the cider to the air, and the higher temperature, within certain limits, the more rapidly does the change take place. About 95° F. is the optimum temperature for economical results. Cider should have a specific gravity of about 1.04 to make first-class vinegar; that of higher specific gravity may be diluted with water or weaker cider; that of lower may be reinforced by the addition of crude glucose.

Vinegar is often made on the farm by storing barrels nearly filled with fresh cider, with their bung open, in the cellar from autumn until the following spring, when the barrels are removed to an outbuilding or a shaded place in the open air. The cider is stirred occasionally by a stick inserted through the bunghole. The vinegar develops much faster if the barrels are stored during winter in a warm room. The acidity of vinegar made in this way varies greatly owing to variation in the richness of the cider used. Cider from early and watery apples will not make strong vinegar.

310. Rapid generation of vinegar. Slightly fermented cider may be changed to vinegar in a few hours by permitting it to trickle into a tank filled with beech shavings, through which air circulates freely. The air is admitted through holes in the side of the tank, and the vinegar collects in the bottom, whence it is syphoned off to another vessel. Sometimes corn-cobs are used instead of beech shavings. Any material that spreads the cider out into thin sheets and that imparts no flavor to it will answer. Special generators for making vinegar by this method are on the market, and when carefully managed, they give good results.

311. Wine is the expressed (and generally fermented) juice of the grape and certain other fruits. The wines of commerce are almost exclusively made from grapes, though foreign materials are sometimes added. The manufacture of wine is an art quite beyond the scope of a book of this sort. Grape growers sometimes convert all or a portion of their crop into wine, disposing of the unfinished product to professional wine makers. A few hints upon the first steps of wine-making are therefore given.

312. Maturity of grapes for wine. The riper grapes are, the more fully is their characteristic flavor developed, and the more sugar and the less acid do they contain. Grapes free from foxiness[1] should be permitted to become fully ripe before gathering (208); foxy varieties are preferably gathered as soon as they are well colored.

The evidences of ripeness in grapes are: (a) the browning and shriveling of the stems; (b) the shriveling of the berry about the stem; (c) the thinness and transparency of the skin; (d) the sweetness and honey-like consistency of the juice.

313. The kind of wine made will depend much upon the method. Light-colored, smooth wines are made by expressing the juice soon after the mashing of the grapes; darker and harsher wines are made by permitting the mashed grapes to ferment more or less before pressing. White wines cannot, however, be made from grapes with dark-colored juice, nor can very dark wines be made from white grapes without artificial coloring. An excess of acid in the unfermented juice (must) may be corrected by the addition of water, and the proper sweetness may be gained by adding sugar. There is, however, a peculiar and delicate aroma in wines from perfectly ripened grapes that cannot be artificially produced.

314. The manufacture of wine on a moderate scale requires less expensive apparatus than the making of cider, unless the wine is carried to the later stages of fermentation, in which case a special cellar is required. The grapes, which should be freed from all unripe or decayed berries, and all superfluous stems, are mashed by passing them be-

[1] Foxiness is the coarse, sour taste characteristic of some varieties of American grapes, notably those derived from *Vitis labrusca* (186).

tween rollers, after which the juice is expressed much as in cider making. The power required in mashing and pressing grapes is less than in the making of cider. Few special appliances are necessary.

SUMMARY OF THE PRECEDING CHAPTER.

1. Storage, to the fruit grower, means the care of fruit from its gathering to its removal to the market or transportation company (286).

2. The maturity of fruit is a step in the direction of decay (287).

3. Moisture on the skin of fruits in storage, and especially breakage of the skin, invite decay (288).

4. The keeping of fruit is promoted by gathering it slightly immature, avoiding injury to the skin, keeping the skin dry, and placing the fruit in a low temperature (289).

5. Fruit may become moist during storage, and on removal from storage, unless care is taken to prevent it (290, 291).

6. Commercial cold-storage may often be profitably used by the fruit grower, especially for the longer-keeping fruits of the best quality (292, 293).

7. A co-operative storage house is not likely to prove satisfactory unless the amount of fruit grown contiguous to the house is large (294).

8. Fruits may be preserved by drying, canning, crystallization, boiling with sugar, and by expressing and treating the juices (296).

9. In warm countries fruits are dried by direct exposure to the sun, but better results may be secured by drying with artificial heat. The evaporation of fruit by means of special apparatus is an important industry in many localities (297, 298).

10. Fruits are canned by cooking them in sealed vessels. Canned fruit may spoil from insufficient cooking or from insufficient heating after sealing (300).

11. Crystallized fruits are prepared by slowly replacing the natural juice with sugar syrup. They keep well in any climate (301).

12. Jams and marmalades are made by boiling the fruit with sugar until the juice is sufficiently concentrated to keep (302). Jellies are made by boiling the juices with sugar (303).

13. The quality of cider depends much upon the richness and ripeness of the apples used (305). Cider apples should be stored where they will absorb no foreign flavors and should be clean and sound (306).

14. Cider is made by reducing the apples to pulp in special machines and extracting the juice by heavy pressure (307). Cider intended for drinking should be filtered (308).

15. Cider, on fermentation, develops a small percentage of alcohol, which on further fermentation becomes vinegar. Cider should have a specific gravity of about 1.04 to make first-class vinegar (309).

16. Commercial wines are the expressed and fermented juice of the grape, more or less pure (311).

17. Grapes continue to develop sugar until fully mature, hence those free from foxiness should be permitted to become fully ripe, for wine (312).

18. The kind of wine made depends much upon the amount of fermentation permitted in the mashed grapes before pressing (313).

19. Wine is made by mashing the grapes between rollers, and extracting the juice by pressure. Water and sugar are often added to the must to regulate the proportion of acid and sugar (314).

SUGGESTIONS FOR LABORATORY WORK.

1. Show the students samples of dried, evaporated and crystallized fruits.

2. So far as practicable, have the students visit places where the manufacture of fruits into secondary products is being carried on.

3. Practice such methods, or make such experiments in the preservation of fruits, as the resources of your institution permit.

CHAPTER VI

BUSINESS MANAGEMENT OF THE FRUIT PLANTATION

315. Importance of good business management. Success in commercial fruit growing depends, perhaps, as much upon good business management as upon the production of good fruit, though this fact has not been generally realized.

Important as are the details of routine management, the highest responsibility connected with the fruit plantation rests on the person who determines its broader policy. The best varieties to grow, the best methods of disposing of the fruits, the best ways of treating the soil, the best implements to use, the best means of catering to the purchaser; these and similar questions call for scientific knowledge and business ability of the highest order.

The subjects that may be properly included under the routine business management are, in the order of their importance: 1st, the marketing of the fruit, 2d, the management of labor and 3rd, the procuring of supplies.

316. Book-keeping. An accurate system of accounts is quite as essential to success in commercial fruit growing as in other commercial occupations. The books should not only show the cash receipts and expenditures, the resources and liabilities, and the time of employes, but in many cases they should show also the accounts with individual varieties, orchards and fields. It is only by these means that the business can be most wisely directed.

Section 1—The Marketing of Fruit

317. The commercial outlets for fruit. Fruit is commonly sold by the grower through one of three channels: (a) To the consumer, (b) to the fruit dealer, and (c) through a middleman who receives the fruit from the grower and sells it for a commission (commission merchant). If the party purchasing or receiving the fruit is located sufficiently near the fruit plantation, the fruit may be delivered to him by wagon; otherwise it will have to be delivered to a transportation company for shipment.

318. Selling to consumers. The best prices may generally be secured by selling directly to the consumer, especially if the fruit is choice and the purchaser is able to pay a "fancy" price. The amount of fruit that can be sold by this method is, however, as a rule, comparatively small, and the time required to make the sale and delivery is relatively large. The largest outlets for fruits by this method are commonly through boarding-houses, restaurants and hotels.

319. Selling to dealers. By this method larger quantities of fruit may commonly be sold for a given effort than by selling to the consumer, but the prices are usually lower. Some growers attempt to sell their choicest fruits to consumers and those of medium quality to dealers, but the two methods are not apt to work well together, as dealers usually object to the grower selling his fruit to consumers.

In sections where insufficient fruit is grown to fully supply the local demand, a large shipping trade may often be developed with dealers in neighboring towns. A list of such dealers may be procured through transportation

agents; and a circular letter describing the kind, quality and prices of stock for sale, with a promise of prompt and regular delivery and solicitation for a trial order, may be mailed to each. The responsibility of unknown parties may be learned through bankers or commercial agencies. Purchasers may generally be found who will deal fairly so long as the grower performs his part conscientiously.

320. Selling to commission merchants. By this method the largest quantities of fruit can be sold, and with the least trouble to the grower, but the prices realized are often unsatisfactory. The grower is, in the nature of the case, largely at the mercy of the commission man, and often has no ready means of knowing to what extent he is fairly dealt with. It is unquestionably true, however, that honorable commission merchants are to be found in nearly every large city, and it is often the grower's highest policy to find these men and to entrust his selling business to them. Having found such a merchant, the grower should lean much upon his judgment and should obey his directions to the letter. Unknown middlemen who solicit trade by circulars and letters, promising prices above the market, should always be regarded with suspicion. The "price currents" sent out by large commission merchants are often helpful, but should not be closely relied upon, as they are not always carefully revised and are at best several hours old before they reach the grower. The telegraph and telephone are better means for securing price quotations from out-of-town markets. Express and railroad agents sometimes find purchasers for goods shipped by their lines, but unless paid a commission, they can hardly be expected to use much effort to secure highest prices.

321. Shipping associations. In districts where numerous persons grow and ship fruit, an association for ship-

ping and selling the produce is usually advantageous. A manager may be employed to devote his time to the interests of the members. He can ascertain the consuming capacity of the towns within profitable shipping distance and the transportation rates to each. This will enable him to send the proper quantities to each town and thus secure better distribution than where each grower ships his own products. By shipping in large quantities, advantage may often be taken of refrigerator cars and carload rates. Small lots of a given variety, grown by different members of the association, can be grouped, thus permitting better prices to be secured for all. The larger fruits, as apples, pears and oranges, are sometimes packed by the association, thus insuring uniform packing. The services of middlemen may sometimes be dispensed with by inducing dealers to purchase directly from the association.

322. Fruits sell largely by appearance. Too much stress can hardly be placed upon the importance of putting up fruit for sale in an artistic manner (15, 17).

323. Printed matter in fruit packages. The use of printer's ink as a means of promoting sales, so fully realized in the mercantile business, seems to be little understood by fruit growers. A neat card, placed in the fruit package where it can be readily displayed by the dealer, stating the uses for which that particular variety is specially adapted, with recipes for its proper treatment, would often promote sales, and would tend to educate consumers to discriminate between the qualities of fruits, which would lead to their larger consumption. Other methods of using printed matter will occur to the thoughtful fruit grower.

Section 2.— The Employment and Management of Labor

324. The object to be attained by labor on the fruit plantation is the performance of the various necessary operations in the proper manner, at the proper time, and at the minimum cost. While few of the operations connected with fruit growing require special skill, there is a best way, and a best time to perform every one. Sufficient labor must be employed to accomplish these ends, and the supervision of this labor must be such as to insure their accomplishment at a minimum cost. The foreman of labor on the fruit plantation has therefore a most responsible position.

325. Qualifications of the foreman. The foreman should not only know the best time and the best method for performing every necessary operation on the fruit plantation, but he should have the tact to induce every assistant to perform the work assigned him according to the highest standard, and at a reasonably rapid rate. The price received for strawberries will depend considerably upon the stage of ripeness at which they are picked, and the manner in which they are handled and placed in the package. The quality of the peach or plum crop will depend much upon the care exercised in thinning the fruit. The foreman's supervision must be continuous and must extend to the smallest details. A persistent process of selection must be exercised with the assistants, retaining, so far as practicable, only the fittest. The wages paid must, of course, be sufficient to retain the best.

326. Organization of labor On large plantations, work will often necessarily be going on at more than one place at the same time. In such cases, a sub-foreman will be

needed for each squad, and the most tactful and loyal workmen should be selected for such positions. The tastes and aptitudes of each individual workman should be carefully observed, and so far as possible each should be detailed to the kind of work that best suits his tastes and abilities.

327. The loyal spirit among workmen. In any business where much labor is employed, the success and economy with which the necessary operations are accomplished will depend considerably upon the mental attitude of the workmen toward their employer. A spirit of loyalty and sympathy among workmen should be promoted by all available means. Strictly fair dealing, reasonable demands and prompt recognition of merit tend to this end. Where many young persons are employed, an occasional picnic or evening entertainment tendered them will do much to foster the loyal spirit. In one case, where a large small-fruit business was carried on, and girls and boys were chiefly employed for picking, the pickers reported at the office at a stated time, formed into line and marched to the field to the music of a drum and fife. This is mentioned as one means of promoting the loyal spirit. There are many others.

Section 3.— The Procuring of Supplies

328. The supplies needed on the fruit plantation are mostly included under (a) implements and machinery; (b) fertilizers; (c) spraying materials; (d) packages, and (e) trees, plants and seeds. The cost of these supplies will depend considerably upon the location and transportation facilities, and upon the methods employed by the purchaser.

329. Aim to secure wholesale rates both in the purchase and transportation of supplies. This often necessitates purchasing in large quantities. When the amount of a given commodity desired is insufficient to secure wholesale prices, aim to make up a club order with other fruit growers, or, if possible, order enough of other needed supplies of the same party to secure special prices on the whole. So far as practicable, have supplies shipped in carload lots.

330. Invite competition. More or less may generally be gained by submitting a list of needed supplies to different manufacturers or dealers, for competitive bids. It may not always be wise to accept the lowest bid in such cases, but the method will insure the opportunity to purchase the articles at a reasonable price.

331. Consider all methods by which the needed supplies may be obtained. Sometimes barrels may be purchased cheapest by buying the heads, hoops and staves of different parties and having the barrels set up on the farm. Sometimes the local planing mill can lay down the materials for crates or boxes cheaper than the regular package manufacturer. Fertilizers may sometimes be obtained cheaper in the by-products of local manufacturers than in the regular market, or they may be obtained still cheaper by keeping stock on the farm. The seed for cover crops, or mulching materials may perhaps, be raised on the farm cheaper than it can be purchased.

SUMMARY OF THE PRECEDING CHAPTER.

1. Success in commercial fruit growing may depend as much upon good business management as upon the production of good fruit (315). A thorough system of accounts should be kept (316).

2. Fruits are commonly sold to consumers, dealers or commission merchants. The first pay best prices, but commonly require only small quantities; the last may use large quantities, but the prices received are often unsatisfactory (317–320).

3. Where several persons in the same community are engaged in fruit growing, a shipping association is generally advantageous (321).

4. Too much care can hardly be given to the appearance of fruit offered for sale, so long as the article is honestly packed (322, 17). Printed matter may often be wisely used in the fruit package (323).

5. The foreman of labor has a most responsible position on the fruit plantation (324, 325).

6. The tastes and aptitudes of each individual workman should be considered (326). All reasonable means should be used to promote a loyal spirit among workmen (327).

7. Efforts should be made to secure wholesale rates in the purchase and transportation of supplies (329). Competition should be invited from dealers and manufacturers (330).

8. All methods for procuring supplies should be considered (331).

SUGGESTIONS FOR LABORATORY WORK.

1. Drill students in a system of book-keeping suitable to a large fruit-growing business. This should include a double-entry system, with a concise method of keeping accounts with different crops.

2. So far as practicable, give students practice not only in the different operations performed on the fruit plantation, but in the management of squads of labor, the marketing of fruit and the purchase of supplies.

3. Require each student to submit a short essay on the best general system of management to be pursued for a given fruit plantation.

To those who desire to study further the subject of commercial fruit growing, the following works will be helpful: Principles of Fruit Growing, Bailey[1]; The Pruning Book, Bailey;[1] American Fruit Culturist, Thomas[3]; Plums and Plum Culture, Waugh[2]; The Nut Culturist, Fuller[2]; The Bush Fruits, Card[1]; Cranberry Culture, Eastman[2], and White[2]; American Grape Growing and Wine Making, Husmann[2]; Harvesting, Storing and Marketing of Fruits, Waugh[2]; The Cider Makers' Hand Book, Trowbridge[2]; The Spraying of Plants, Lodeman[1]; Insects Injurious to Fruits, Saunders[4]; Cyclopedia of American Horticulture, edited by Bailey[1]; Reports and Bulletins of government experiment Stations; Reports, Yearbooks and Bulletins of the United States Department of Agriculture; Transactions of State horticultural societies.

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[1] Published by the Macmillan Company, New York.
[2] Published by the Orange Judd Company, New York.
[3] Published by Wm. Wood & Company, New York.
[4] Published by the J. B. Lippincott Company, Philadelphia.

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